

ORIGINAL ARTICLE OPEN ACCESS

Irreversible Electroporation for Inferior Turbinate Reduction Ablation in Adults

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Received: 28 March 2026 | **Revised:** 9 August 2026 | **Accepted:** 2 September 2026

Keywords: Electroporation | Inferior turbinate reduction | tissue ablation

ABSTRACT

Background: Inferior turbinate hypertrophy is a common cause of nasal airway obstruction. An optimal surgical approach should provide effective volume reduction while preserving mucosal integrity and minimizing postoperative morbidity.

Objective: To evaluate the safety and efficacy of irreversible electroporation (IRE) for non-thermal ablation of inferior turbinate hypertrophy.

Methods: This prospective, multi-center, single-arm study included adult patients with symptomatic nasal obstruction due to inferior turbinate hypertrophy refractory to medical therapy. All patients underwent IRE turbinate reduction using the ENTire system. Outcomes were assessed using the Nasal Obstruction Symptom Evaluation (NOSE), Nasal Obstruction Visual Analog Scale (NO-VAS), and the 22-item Sino-Nasal Outcome Test (SNOT-22) at baseline and at 1 week, 1 month, and 3 months. Postoperative pain and clinical healing were also evaluated.

Results: Forty-eight patients completed the study. Significant improvement was observed across all outcome measures. The mean NOSE score decreased from 74.38 ± 13.39 to 11.25 ± 9.20 , the NO-VAS score from 69.55 ± 19.48 to 12.51 ± 11.81 , and the SNOT-22 score from 33.06 ± 24.18 to 7.48 ± 10.37 at 3 months (all $p < 0.0001$). Improvement was evident at 1 week and progressed through follow-up. Postoperative pain was low. No major complications occurred, and transient mucosal changes resolved by 3 months.

Conclusion: IRE is a promising non-thermal, minimally invasive technique for inferior turbinate reduction, providing significant symptom improvement with low postoperative morbidity. Larger studies with longer follow-up are needed to confirm durability.

1 | Introduction

Electroporation uses pulsed electrical fields to increase cell membrane permeability. At higher energy levels, this becomes irreversible, leading to cellular apoptosis and tissue ablation. As a non-thermal modality, it enables targeted tissue reduc-

tion while minimizing collateral damage [1]. As a non-thermal modality, IRE may reduce post-operative pain and allows for shorter procedural times due to microsecond pulse delivery. It has been increasingly applied for tissue ablation in conditions such as liver malignancies, cardiac arrhythmias, and prostate cancer [2–4].

This article was accepted for oral presentation at the ARS-COSM 2026 Annual Meeting Phoenix Arizona, April 2026.

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Inferior turbinate hypertrophy is a common cause of nasal airway obstruction. Management typically begins with medical therapy; but a substantial proportion of patients eventually require second-line procedures, aimed at improving nasal airflow while preserving mucosal function [5] with good long term results [6]

Over the past two decades, the number of turbinate reduction procedures has increased steadily, reflecting its widespread use in clinical practice [7]. This is reflected in the wide range of surgical techniques that have been developed [5].

Real-world data have shown high rates of clinical success and low complication profiles following turbinate surgery, supporting its effectiveness in routine practice [8, 9]. Comparative studies have demonstrated largely similar clinical outcomes, with no single approach consistently shown to be superior [9–11]. Slight advantage was noted in favor of micro-debrider-assisted technique in both long-term durability and QOL-specific outcomes [12].

Mucosal-preserving techniques aim to minimize complications secondary to mucosal injuries. However, transient complications including pain, bleeding (4%), crusting (17%), nasal dryness (2%) and prolonged recovery are still frequently reported [6, 13], especially in the short termed post-operative period.

IRE has been associated with reduced postoperative pain in several oncologic applications. In pancreatic cancer, IRE was reported to result in lower postoperative pain than cryoablation [14], with similar observations described in hepatocellular carcinoma and other tumor settings [15, 16]. Proposed mechanisms include the short ablation duration and relative preservation of the extracellular matrix [15]. In renal tumors amenable to IRE, pain scores were also lower than those reported with radiofrequency ablation, independent of tumor location [17].

In recent years, the field of IRE has undergone substantial technological development, enabling the use of higher voltages and pulse frequencies. These advances have shortened overall ablation time and may reduce neuromuscular stimulation and skeletal-muscle contractions. More recently, early data on IRE-based tonsil treatment demonstrated low postoperative pain and no bleeding events [18].

Together, these findings support the rationale that nonthermal IRE may offer favorable perioperative and recovery characteristics for inferior turbinate reduction. Its use may reduce postoperative pain and crusting while shortening procedural time; however, these potential advantages require confirmation in larger comparative studies.

To our knowledge, this is the first clinical study to evaluate an IRE system for inferior turbinate reduction.

2 | Materials and Methods

This is a prospective, multicenter single-arm, non-blinded study. The study was conducted in Israel, Lithuania, Uzbekistan, and Romania. Ethical approval was obtained from the all relevant centers, with detailed approval of the institutional boards and health ministry described in Supplementary table 1. Informed consent

was obtained from each patient prior to the procedure. This clinical investigation is registered in Europe as CIV-ID: RO-23-11_044856 and CIV-ID: LT-24-05-047661 and is an Interventional study and may be found on ClinicalTrials.gov, ID NCT06438185.

Study participants: Adult patients aged 18–70 years with symptomatic nasal obstruction primarily attributed to inferior turbinate hypertrophy were recruited for this study. Eligibility required a baseline NOSE score [19] ≥ 60 , indicating severe nasal obstruction.

Inferior turbinate hypertrophy as a major contributor to nasal obstruction was confirmed by a positive response to topical vasoconstriction during in-office examination. A positive response to topical vasoconstriction was defined as patient-reported symptomatic relief accompanied by a marked improvement in inferior turbinate size on physical examination by an experienced rhinologist.

All patients had persistent symptoms despite prior medical therapy, including treatment with topical intranasal corticosteroids for at least 3 months.

Exclusion criteria included age <18 years; presence of a pacemaker or other implanted electrical stimulation device; caudal septal deviation significantly narrowing the anterior nasal valve; nasal polyps or tumors; chronic rhinosinusitis; blood eosinophilia; severe cardiovascular disease; epilepsy or other seizure disorders; pregnancy or breastfeeding; prior inferior turbinate surgery; or prior nasal surgery (including rhinoplasty or septoplasty) within 6 months. Chronic rhinosinusitis was excluded based on clinical history and nasal endoscopic examination. Computed tomography imaging was reviewed when available or clinically indicated but was not routinely required solely to exclude CRS.

Additional exclusions included significant systemic illness (e.g., malignancy, severe autoimmune or neurological disease), bleeding diathesis or coagulation disorders, high anaesthetic risk, known hypersensitivity to anesthetic agents or medications used in the procedure, and inability to provide informed consent, complete patient-reported outcome measures, or comply with treatment and follow-up.

Study protocol: Preoperative evaluation included a comprehensive nasal examination, including anterior rhinoscopy and nasal endoscopy, performed by an experienced rhinologist. Inferior turbinate size, mucosal appearance, septal deviation, and other potential anatomic contributors to nasal obstruction were assessed before and after topical vasoconstriction application (vasoconstriction test). Patients completed validated patient-reported outcome measures, including the Nasal Obstruction Symptom Evaluation (NOSE) score, Nasal Obstruction Visual Analog Scale (NO-VAS), and the Sinonasal Outcome Test (SNOT-22).

The first follow-up visit was conducted at 1 week and included clinical nasal examination and assessment of symptoms. Additional follow-up visits were conducted at 1 month and 3 months, including repeat nasal examination and administration of patient-reported outcome measures (NOSE, NO-VAS,

and SNOT-22). Post-procedural pain was recorded in discharge evaluated as a secondary endpoint. Immediate nasal pain was recorded at discharge using a 0–10 pain-rating measure. Participants subsequently completed a 0–10 pain visual analog scale (VAS) at the 1-week, 1-month, and 3-month follow-up visits. All clinical assessments and questionnaire administration were performed in accordance with the study protocol by a board certified otolaryngologist, with fellowship training in rhinology.

A structured classification system was used to characterize findings on physical examination based on observable tissue properties. The following examination variables were assessed: blanching, bleeding, mucosal damage/crusting, swelling, and ulceration. Each variable was graded according to severity using a four-level scale: not present, mild, moderate, and severe, based on predefined criteria. In addition, tissue characteristics were categorized according to the predominant pattern observed on examination. Each case was assigned a severity grade for each examination variable, along with an overall pattern classification based on the dominant physical findings in each time point (1 week, one month and 3 months)

The IRE procedure: The procedure was performed under general anesthesia, sedation with local anesthesia, or local anesthesia alone, at the discretion of the treating surgeon and based on patient factors. Inferior turbinate reduction was performed using an irreversible electroporation (IRE) system (ENTire Medical Ltd., Herzliya, Israel), consisting of a generator and a bipolar handpiece designed to deliver short, high-voltage electrical pulses to the target tissue, inducing non-thermal irreversible electroporation and subsequent tissue reduction (Figure 1).

The handpiece, shaped as bipolar forceps, was applied directly to the inferior turbinate with light-to-moderate pressure to ensure adequate contact between the electrodes and tissue (figure 1). Electrical pulses of microsecond duration were delivered via a foot pedal-controlled system. Treatment was performed at multiple sites along the turbinate (typically anterior, middle, and posterior), with repeated applications as needed based on turbinate size and intraoperative assessment.

Cardiac rhythm was continuously monitored using electrocardiography during the procedure. Total procedure time was approximately 30 min, including general anaesthesia.

Postoperatively, patients were monitored for several hours, according to institutional protocol. Analgesics, including nonsteroidal anti-inflammatory drugs, were prescribed as needed for pain control.

Pain assessment and Questionnaires: Pain was assessed using a visual analog scale (VAS) ranging from 0 (no pain) to 10 (worst imaginable pain). Nasal obstruction severity was evaluated using the Nasal Obstruction Symptom Evaluation (NOSE) score, a validated patient-reported outcome measure assessing the impact of nasal obstruction on quality of life [20].

Additional symptom assessment was performed using the Nasal Obstruction Visual Analog Scale (NO-VAS), in which patients rated the severity of nasal obstruction on a continuous scale.

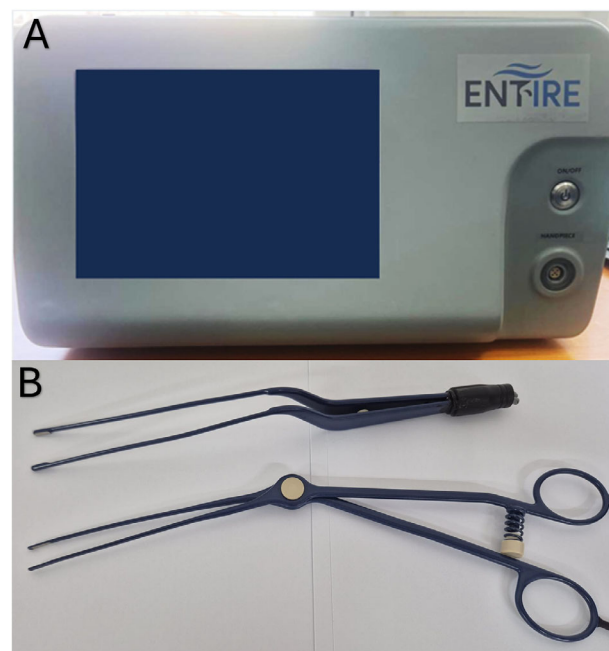


FIGURE 1 | IRE generator and nasal handpieces. (A) ENTire irreversible electroporation generator used to deliver nonthermal bipolar electrical pulses. (B) Nasal handpieces used for inferior turbinate treatment, including the angled bipolar electrode handpiece (upper panel) and the ring-handled bipolar forceps handpiece (lower panel). The slim, angled configuration allows controlled submucosal application within the nasal cavity.

Disease-specific quality of life was further assessed using the 22-item Sino-Nasal Outcome Test (SNOT-22), a validated questionnaire evaluating the physical and functional impact of sinonasal disease [21]. All questionnaires are validated instruments commonly used in the assessment of nasal obstruction and sinonasal disease.

2.1 | Statistical Analysis

All measured variables and derived parameters were summarized using descriptive statistics.

Categorical variables are presented as frequency and percentage, along with 95% confidence intervals calculated using the Clopper-Pearson method. Continuous variables are presented as sample size, mean $\pm$ standard deviation, median, minimum, and maximum values.

Changes in outcome measures from baseline to follow-up were analyzed using the Wilcoxon signed-rank test, as appropriate. All statistical tests were two-tailed, and a p-value ≤ 0.05 was considered statistically significant. Statistical analyses were performed using SAS software, version 9.4 (SAS Institute, Cary, NC, USA).

3 | Results

Forty-eight patients met inclusion criteria and were included in the study, all of whom completed the 3-month follow-up and were included in the final analysis. The mean participants' age was 35.6

TABLE 1 | cohort characteristics.

Parameter (unit)	Mean $\pm$ SD, Range; (n, (%))
Age (years)	35.6 $\pm$ 12.8 (18 - 64)
Gender (Male)	26, (54)
Height (cm)	171.6 $\pm$ 9.4 (152 - 197)
Weight (kg)	73.9 $\pm$ 15.0 (50 - 105)
Ethnicity	
Caucasian	32, (66.7)
Asian	16, (33.3)
Smoking status	
Current	4, (8%)
Past	6, (13%)
Never	38 (79%)
Quality of Life (Baseline)	
Mean SNOT-22 score (baseline)	33.1 $\pm$ 24.18.
Mean NO-VAS score (Baseline)	69.6 $\pm$ 19.5 (29 – 100)
Mean NOSE score (Baseline)	74.4 $\pm$ 13.4 (60 – 100)
NOSE score by severity (Baseline)	
Mild (range, 5-25)	0
Moderate (range, 30-50)	0
Severe (range, 55-75)	32 (67%)
Extreme (range, 80-100)	16 (33%)

$\pm$ 12.8, ranging between 18 – 64 years. There was a slight male predominance, with 26 male participants (54%) and 24 female participants (46%). Mean baseline NOSE and NO-VAS scores were 74.38 $\pm$ 13.39 and 69.5 $\pm$ 19.54, respectively. The mean SNOT-22 score at baseline was 33.1 $\pm$ 24.18 (Table 1).

36 (75%) patients were operated on under local anesthesia, 10 patients (20.83%) were operated under sedation only, and only the first two patients were operated under general anesthesia (4.17%).

No major complications occurred during any of the procedures. Only one patient experienced

Intra-operative bleeding, that was stopped uneventfully with electric cautery. No complications occurred during any of the procedures. The overall net procedural time for all procedures was 12.23 $\pm$ 12.75 and for local procedures only, was 7.63 $\pm$ 4.38 min.

Minor, transient postoperative symptoms were reported and resolved without intervention. The mean pain score at discharge was 2.3 $\pm$ 1.9. The mean post-operative pain at one week following the procedure was 0.78 $\pm$ 1.86 indicating low levels of discomfort.

At 1-week follow-up, significant improvement was observed across all outcome measures. The mean NOSE score decreased from 74.38 $\pm$ 13.39 at baseline to 39.06 $\pm$ 27.13, and the mean

NO-VAS score decreased from 69.55 $\pm$ 19.48 to 41.52 $\pm$ 30.23. The mean SNOT-22 score improved from 33.06 $\pm$ 24.18 to 19.69 $\pm$ 20.07. These changes corresponded to relative reductions of 48.62%, 40.41%, and 42.26%, respectively, and were all statistically significant ($p < 0.0001$) (Table 2, Figure 2).

At 1-month follow-up, further improvement was observed across all outcome measures. The mean NOSE score decreased to 17.71 $\pm$ 15.61, and the mean NO-VAS score decreased to 19.71 $\pm$ 17.21. The mean SNOT-22 score improved to 9.54 $\pm$ 12.78. These changes represented relative reductions of 76.21%, 71.31%, and 76.59%, respectively, compared to baseline, and remained statistically significant ($p < 0.0001$) (Table 2, Figure 2).

At 3 months follow up, significant improvement was observed in all outcome measures. The mean NOSE score decreased to 11.25 $\pm$ 9.2, and the mean NO-VAS score decreased to 12.48 $\pm$ 11.88. The mean SNOT-22 score improved to 7.48 $\pm$ 10.37. These changes corresponded to relative reductions of 85.08%, 82.02%, and 82.59%, respectively and were all statistically significant (Table 1, 2, Figure 2).

As for the physical examination findings during the healing process, transient mucosal changes were observed in the early postoperative period and resolved progressively over time. At discharge, mild swelling (1.13 $\pm$ 0.70), blanching (0.69 $\pm$ 0.69), and mucosal crusting (0.63 $\pm$ 0.67) were noted. Swelling demonstrated the most pronounced early improvement, decreasing significantly by 1 week (mean change -0.79 ± 0.58 , $p < 0.0001$) and continuing to improve at 1 month (-1.08 ± 0.68 , $p < 0.0001$), with complete resolution observed at 3 months (0.00 $\pm$ 0.00; $p < 0.0001$). Blanching showed a similar pattern, with no significant change at 1 week ($p = 0.2468$), followed by complete resolution at 1 month and 3 months (0.00 $\pm$ 0.00; $p < 0.0001$) (Table 3, Figure 3).

Mucosal crusting did not significantly change at 1 week ($p = 0.59$), but demonstrated significant improvement by 1 month (mean change -0.54 ± 0.82 , $p < 0.0001$) and near-complete resolution at 3 months (0.02 $\pm$ 0.14; $p < 0.0001$) (Table 3, Figure 3).

Bleeding was minimal, with a low incidence at discharge (0.06 $\pm$ 0.24) and no cases observed at subsequent follow-up visits. Ulceration was rare, with negligible occurrence throughout the study period and no significant changes over time ($p = 1.000$ at all time points). (Table 3, Figure 3)

4 | Discussion

This is the first study to report the safety and efficacy of an irreversible electroporation (IRE)-based technology for inferior turbinate reduction. Our findings demonstrate significant improvement in nasal obstruction and quality of life, with rapid symptom relief observed as early as 1 week and sustained improvement through 3 months. In addition, the procedure was associated with low postoperative pain and a favorable safety profile, with no major complications observed.

Inferior turbinate reduction is a commonly performed procedure for the treatment of nasal airway obstruction secondary to turbinate hypertrophy [5]. While a wide range of surgical

TABLE 2 | Quality of life measurements score difference between baseline at 1 week, 1 month and 3-month time points (N = 48).

Parameter	Time Point	Mean± SD; Median	Change from baseline	Relative Change from baseline (%)	p-value signed-rank test
NO-VAS	Baseline	69.55±19.48; 71.36			.
NO-VAS	1 Week	41.52±30.23; 36.27	-28.03±27.66; -26.31	-40.41±39.05; -36.00	<.0001
NO-VAS	1 Month	19.71±17.21; 15.37	-49.84±21.79; -50.01	-71.31±26.58; -79.53	<.0001
NO-VAS	3 Months	12.51±11.81; 10.50	-57.04±18.84; -54.47	-82.02±19.90; -86.67	<.0001
NOSE	Baseline	74.38±13.39; 72.50			.
NOSE	1 Week	39.06±27.13; 37.50	-35.31±23.95; -37.50	-48.62±34.66; -50.00	<.0001
NOSE	1 Month	17.71±15.61; 15.00	-56.67±18.20; -60.00	-76.21±21.41; -80.00	<.0001
NOSE	3 Months	11.25±9.20; 10.00	-63.13±13.55; -65.00	-85.08±12.30; -87.08	<.0001
SNOT-22	Baseline	33.06±24.18; 23.00			.
SNOT-22	1 Week	19.69±20.07; 12.00	-13.38±15.46; -9.00	-42.26±41.07; -44.25	<.0001
SNOT-22	1 Month	9.54±12.78; 4.00	-23.52±18.40; -16.00	-76.59±23.08; -84.72	<.0001
SNOT-22	3 Months	7.48±10.37; 3.00	-25.58±19.68; -18.50	-82.59±19.93; -85.88	<.0001

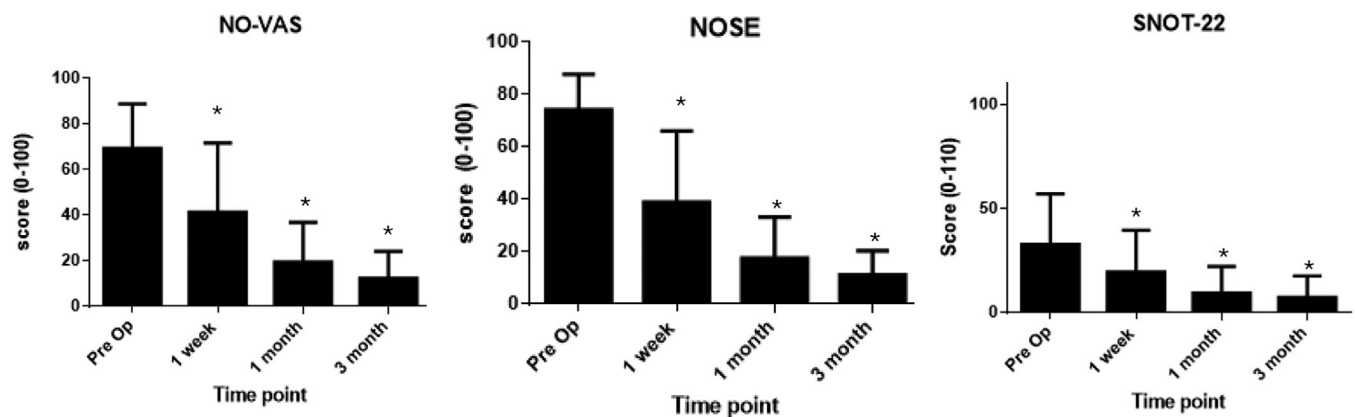


FIGURE 2 | Patient-reported outcomes following IRE inferior turbinate reduction. Mean NO-VAS, NOSE, and SNOT-22 scores at baseline and at 1 week, 1 month, and 3 months after treatment, demonstrating significant improvement among our cohort from baseline during follow-up period. Error bars represent standard deviations. *p < 0.05 compared with baseline.

techniques exist, the ideal approach remains one that achieves effective volume reduction while preserving mucosal function and minimizing postoperative morbidity [7]. In the present study, our cohort demonstrated marked improvement in validated patient-reported outcome measures, including NOSE, NO-VAS, and SNOT-22 scores. Given the prospective, single-arm design and relatively limited sample size, conclusions regarding comparative efficacy should be made with caution. Nevertheless, the consistent improvement across multiple validated outcome measures supports the clinical potential of this approach.

Postoperative pain, crusting and bleeding remains an important consideration in turbinate surgery [22, 23]. Thermal techniques, including radiofrequency ablation and electrocautery, may be associated with mucosal injury and discomfort during the healing process [10]. In contrast, the non-thermal mechanism of IRE may contribute to reduced postoperative pain by preserving surrounding tissue architecture. In our cohort, postoperative pain levels were low at 1 week throughout the entire follow up period, supporting the hypothesis that non-thermal ablation may reduce

procedure-related discomfort. The mean post procedural pain score at discharge was 2.3±1.9 and remained low at 1 week and throughout follow-up. However, immediate pain may have been influenced by anesthesia modality and assessment timing. In retrospect, standardized discharge pain assessment stratified by anesthesia type would have better characterized the postoperative course. Pain was not assessed at prespecified intra-procedural intervals or through daily post-procedural pain diaries. In addition, the variability in anesthesia modality precluded meaningful comparison of intra-procedural pain across participants. These factors limit characterization of the immediate perioperative pain course and the generalizability of these findings to that period.

Safety outcomes in this study were favorable. Transient mucosal changes, including swelling, blanching, and crusting, were observed in the early postoperative period but resolved progressively over time. Importantly, no significant bleeding or ulceration was observed, and no major complications occurred. These findings are consistent with the mechanism of IRE, which induces cellular apoptosis without significant disruption

TABLE 3 | Physical examination score difference between baseline at 1 week, 1 month and 3-month time points (N = 48).

Exam Variable	Time Point	Measure	Mean± SD; Median	Score difference	p-value signed-rank test
Blanching	Discharge	Score	0.69±0.69; 1.00		.
Blanching	1 Week	Score	0.54±0.68; 0.00	−0.15±0.80; 0.00	0.2468
Blanching	1 Month	Score	0.00±0.00; 0.00	−0.69±0.69; −1.00	<.0001
Blanching	3 Months	Score	0.00±0.00; 0.00	−0.69±0.69; −1.00	<.0001
Bleeding	Discharge	Score	0.06±0.24; 0.00		.
Bleeding	1 Week	Score	0.00±0.00; 0.00	−0.06±0.24; 0.00	0.2500
Bleeding	1 Month	Score	0.00±0.00; 0.00	−0.06±0.24; 0.00	0.2500
Bleeding	3 Months	Score	0.00±0.00; 0.00	−0.06±0.24; 0.00	0.2500
Mucosal damage Crust	Discharge	Score	0.63±0.67; 1.00		.
Mucosal damage Crust	1 Week	Score	0.67±0.63; 1.00	0.04±0.62; 0.00	0.5913
Mucosal damage Crust	1 Month	Score	0.08±0.35; 0.00	−0.54±0.82; −1.00	<.0001
Mucosal damage Crust	3 Months	Score	0.02±0.14; 0.00	−0.60±0.71; −1.00	<.0001
Swelling	Discharge	Score	1.13±0.70; 1.00		.
Swelling	1 Week	Score	0.33±0.56; 0.00	−0.79±0.58; −1.00	<.0001
Swelling	1 Month	Score	0.04±0.20; 0.00	−1.08±0.68; −1.00	<.0001
Swelling	3 Months	Score	0.00±0.00; 0.00	−1.13±0.70; −1.00	<.0001
Ulceration	Discharge	Score	0.00±0.00; 0.00		.
Ulceration	1 Week	Score	0.02±0.14; 0.00	0.02±0.14; 0.00	1.0000
Ulceration	1 Month	Score	0.00±0.00; 0.00	0.00±0.00; 0.00	1.0000
Ulceration	3 Months	Score	0.00±0.00; 0.00	0.00±0.00; 0.00	1.0000.

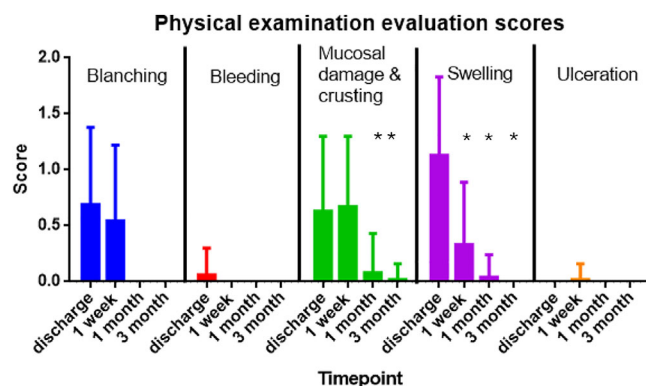


FIGURE 3 | Post-treatment physical examination findings following IRE inferior turbinate reduction. Mean examination scores for blanching, bleeding, mucosal damage/crusting, swelling, and ulceration at discharge and at 1 week, 1 month, and 3 months after treatment. Error bars represent standard deviations. * $p < 0.05$ and ** $p < 0.01$ compared with discharge.

of extracellular structures, potentially reducing the risk of tissue damage and associated complications [3].

In recent years, there has been increasing interest in minimally invasive and mucosal-preserving techniques for inferior turbinate reduction. While approaches such as radiofrequency ablation and microdebrider-assisted turbinoplasty have demonstrated good clinical outcomes [11, 12], differences in efficacy and compli-

cation profiles remain modest. The present findings suggest that IRE may offer an alternative approach with favourable recovery characteristics, particularly with respect to early symptom improvement and low postoperative morbidity with highly efficient procedure necessitating only local anaesthesia and requiring several minutes.

Irreversible electroporation is an emerging non-thermal ablation technique that has been increasingly used in other fields, including cardiac arrhythmias and oncologic applications. Its ability to induce targeted cell death while preserving surrounding structures is a key advantage over thermal modalities [3]. In the context of turbinate hypertrophy, this may translate into effective tissue reduction with preservation of mucosal function and improved postoperative recovery. Notably, no cases of crusting or bleeding were observed throughout the post operative study period, suggesting a favorable safety profile of the intervention. In addition, patients demonstrated significant early-phase improvement in clinical findings, supporting a rapid tissue recovery response. These observations may indicate that the technique minimizes mucosal trauma while promoting early healing, although larger studies are needed to confirm these findings.

The present study has several limitations. The sample size is relatively small, and the study design was single-arm without a control group, limiting the ability to directly compare outcomes with other established techniques. Mucosal status was assessed by an experienced rhinologist rather than an independent blinded

examiner, which may have introduced observer bias. In addition, procedural parameters, including energy settings and treatment protocols, may require further optimization. Another limitation of this preliminary study is the lack of objective nasal air-flow assessment, such as peak nasal inspiratory flow, acoustic rhinometry, or rhinomanometry. Future studies should incorporate objective physiologic measures alongside patient-reported outcomes. The follow-up period of 3 months was sufficient to demonstrate early efficacy and safety; however, longer-term follow-up is necessary to assess durability of effect and potential recurrence of symptoms.

Despite these limitations, the findings of this study are promising. The combination of significant symptom improvement, low postoperative pain, and a favorable safety profile supports the potential role of IRE as a treatment option for inferior turbinate hypertrophy. Larger, multicenter studies with longer follow-up are required to confirm these findings and further define the role of this technology in clinical practice.

Author Contributions

Narin N Carmel Neiderman: study design, statistical analysis, writing – original draft and revising the original draft; sarafoleanu codrut: study design, data collection, editing and review of manuscript. **Ionut Tanase:** data collection, editing and review of manuscript. **Mihai Alexandru Pascu:** data collection, data curation, critical review of manuscript. **Desiderio Passali:** conceptualization, critical review of manuscript. **Ulugbek Saidakramovich Khasanov:** data collection, data curation; **Sobirjonovich Matmuratov Zukhrob:** data collection, data curation. **Marius Polianskis:** data collection, data curation, **Eugenijus Lesinskas:** data collection, data curation. **Avraham Abergel:** Principal Investigator, Conceptualization, study design, writing – original draft

Conflicts of Interest

This study was funded by ENTire. The sponsor provided financial support for the study but had no role in the study design, data collection, data analysis, interpretation of results, manuscript preparation, or the decision to submit the manuscript for publication. The authors declare no additional conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supplement Table 1: Ethical approval no. in the 5 participating centers.