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A Comparative Study on the Clinical Outcome of Carbondioxide Laser Turbinate Reduction Versus Submucosal Diathermy in Patients with Hypertrophied Inferior Turbinate

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ABSTRACT

Background: The inferior turbinates are essential structures that form a crucial part for the normal functioning of the nose. Inferior turbinate hypertrophy causing nasal obstruction significantly affects the quality of life. Even though various surgical measures are available, both submucosal diathermy and carbon dioxide LASER procedures has got several advantages over other turbinate reduction surgeries. With this background, this study aims to compare the clinical improvement between patients who underwent submucosal diathermy surgery and carbon dioxide LASER procedure of hypertrophied inferior turbinate.

Objectives: To compare the clinical outcome of submucosal diathermy and LASER turbinate reduction in patients with nasal obstruction due to inferior turbinate hypertrophy refractory to medical treatment.

Method: A prospective observational study was conducted at the Department of ENT, Government Medical College, Thiruvananthapuram, over a period of 18 months. Data on 32 patients who had underwent one of the two surgical interventions either LASER turbinate reduction or submucosal diathermy for inferior turbinate hypertrophy resistant to medical treatment was compiled, with assessments before and after the procedures. The clinical outcome was compared pre and post procedure via subjective (SF36 Questionnaire) and objective (Peak Nasal Inspiratory Flow) methods.

Results: Both treatment groups showed symptomatic improvement at first- and third-month follow-up. However, patients who underwent Laser surgery demonstrated a significant improvement in PNIF values compared with those treated with SMD ($p < 0.05$). Crust formation was the most frequent postoperative complication, observed in 62.5% of CO_2 LTR cases and 93.7% of SMD cases at 1-month follow-up.

Conclusion: Lase turbinate reduction of hypertrophied inferior turbinate showed superior clinical outcomes in terms of recovery and nasal function compared to SMD.

Keywords: *Inferior turbinate hypertrophy, 36-item Short Form survey Questionnaire (SF36 Questionnaire), Peak Nasal Inspiratory Flowmetry, Carbon dioxide LASER, Submucosal diathermy.*

BACKGROUND

Inferior turbinate hypertrophy (ITH) is one of the most common causes of chronic nasal obstruction, leading to significant discomfort and deterioration in quality of life. The condition is frequently associated with allergic rhinitis, vasomotor rhinitis, idiopathic rhinitis, compensatory hypertrophy due to septal deviation, and rhinitis medicamentosa. In addition to nasal obstruction, affected patients often experience sneezing, rhinorrhoea, nasal itching, and hyposmia. Chronic

inflammation of the nasal mucosa results in submucosal collagen deposition and tissue remodelling, ultimately leading to persistent hypertrophy of the inferior turbinate. While medical management with antihistamines, intranasal corticosteroids, and topical decongestants may provide temporary relief, a considerable proportion of patients fail to respond and require surgical intervention.

A variety of surgical procedures have been developed to achieve turbinate size reduction or removal. These include lateralization through outfracture, microdebrider-assisted turbinoplasty, radiofrequency ablation, coblation, turbinoplasty, surface cauterization, cryosurgery, LASER treatment, submucosal diathermy (SMD), and partial turbinectomy.

Submucosal diathermy is a monopolar cautery technique in which an insulated Abbey needle is passed along the inferior turbinate in two to three tracks, delivering diathermy energy at approximately 70 W during withdrawal. The generated heat causes tissue destruction, inflammation, and subsequent fibrosis, thereby reducing turbinate ulk. However, excessive diathermy can result in necrosis, prolonged crusting, and delayed healing.

LASER turbinate reduction has emerged as a minimally invasive alternative that allows excision, vaporization or coagulation and can be performed under local anaesthesia. Among various LASER types, the carbon dioxide LASER is particularly suited for cutting and vaporizing soft tissue, with an effective penetration depth of about 4 mm and limited collateral damage. Typically, CO_2 laser energy is applied in a repeat mode at 4 W for 10 milliseconds across the anterior, middle, and posterior thirds of the turbinate.

Both CO_2 LTR and SMD are effective techniques for the management of inferior turbinate hypertrophy, offering advantages such as reduced bleeding, minimal pain, faster recovery, and the feasibility of performing the procedure under local anaesthesia in an outpatient setting.

The effectiveness of turbinate surgery is best evaluated using both objective and subjective measures of nasal airflow improvement. At present, no specialized quality-of-life assessment tool exists specifically for turbinate reduction surgery. A decrease in nasal discharge and sneezing may occur due to the destruction of the highly vascular submucosa, sero mucinous glands, and the severing of postnasal nerve branches, which play a role in sneezing and excessive secretion. Furthermore, as nasal airflow improves, patients may notice an enhancement in their sense of smell.

While rhinomanometry and acoustic rhinomanometry are the primary methods for assessing nasal airflow, other tools like Peak Nasal Inspiratory Flow (PNIF) also offer valuable insights into nasal patency. Rhinomanometry evaluates nasal function by measuring resistance to airflow, which is calculated using nasal airflow and transnasal pressure. In contrast, acoustic rhinomanometry offers an anatomical assessment by measuring the cross-sectional area or volume of the nasal cavity. PNIF is a cost-effective, quick, portable, and straightforward technique that does not require computer-based data analysis. The maximum airflow through the nose during inhalation or exhalation, achieved with maximal respiratory effort, serves as an indicator of nasal conductance. Unlike rhinomanometry, which provides an indirect assessment of nasal obstruction, PNIF offers a direct measurement.

In the present study, the clinical outcomes of these two techniques were evaluated by comparing pre- and postoperative findings using both subjective and objective assessment tools. Subjective assessment was performed using the 36-item Short Form (SF-36) questionnaire, which quantifies symptom severity on a five-point scale. Objective evaluation of nasal airflow was carried out using Peak Nasal Inspiratory Flow (PNIF), a practical and cost- effective alternative to anterior and acoustic rhinomanometry, providing comparable reliability and reproducibility

MATERIALS AND METHODS

Study Design and Setting

This study was designed as hospital based prospective observational study and was conducted in the Department of Otorhinolaryngology, Government Medical College, Thiruvananthapuram, Kerala, India, over an 18-month period from September 2023 to March 2025.

Study Population and subject

This study included patients aged 18–60 years presenting with nasal obstruction due to inferior turbinate hypertrophy refractory to medical therapy and who underwent LASER turbinate reduction or submucosal diathermy in the Department of Otorhinolaryngology in Government Medical College, Thiruvananthapuram. Patients with history of previous nasal surgery or nasal trauma, pregnant women and patients on oral contraceptive pills and those not given consent for participation were excluded from the study.

Study period

This study was conducted over a period of 18 months from September 2023 to March 2025 after IEC approval'

Sample Size estimation
The sample size was derived according to a previous comparative study between electrical submucosal diathermy and diode laser treatment of inferior turbinate hypertrophy conducted at the College of Medicine, University of Babylon, Iraq1 by using the formula

$$n = \frac{((Z_{1-\frac{\alpha}{2}}) + (Z_{1-\beta}))^2 \; x \; (p_1q_1 + p_2q_2)}{(p_1 - p_2)^2}$$

p1= 100 % = 1 p2 = 80%= 0.8
q1=0 q2= 0.2

$n = (1.96+0.84)^2 \times (1\times0+0.8\times0.2) \div (1-0.8)^2$
n= 31.25= 32

Hence, a sample size of 32 patients was determined

Study Variables.
Variables included in this study were socio-demographic data, pre operative and postoperative symptom scores, Anterior rhinoscopic findings, pre operative and post operative Peak Inspiratory flowmetry values.

Data Collection tool and Procedure
A semi structured proforma was used to collect the required information. Data on 32 patients, 16 patients who underwent LASER and 16 who underwent SMD for inferior turbinate hypertrophy resistant to medical treatment was compiled, with assessments before and after the operations. Preoperative and postoperative evaluations were performed using subjective (SF36 Questionnaire) and objective (PNIF) methods. 5-point scoring was done for nasal obstruction, sneezing, running nose, itchy nose and stuffy nose (score 5 to 25) according to SF36 Questionnaire. Total Symptom scoring ranges from 5 to 25.

1) No symptoms
2) Mild symptoms without discomfort
3) Moderate symptoms with discomfort without impairment of daily activities
4) Moderate symptoms with discomfort with impairment of daily activities
5) Severe symptoms with severe impairment in daily activities and or sleep

Peak Nasal Inspiratory Flow (PNIF) was used to evaluate nasal patency. Face mask with seal was kept over nose with mouth closed. After maximal expiration the patient sniffs air through the nose maximally and peak flow was recorded. PNIF procedure repeated 3 times and highest of three values of PNIF (peak nasal inspiratory flowmetry) was taken in L/minute (30- 370L/mt). Standard PNIF value in adult male is 143L/min and in females 122L/minute. Value of less than 115L/mt indicates significant obstruction. Difference of 25L/mt between pre and post procedure values is considered significant. Follow-up assessments were conducted at 1 month and 3 months post procedure. At each follow-up, nasal endoscopy was also performed to evaluate mucosal healing and complications such as crusting.

ETHICAL CONSIDERATION
The study was initiated after getting clearance from the Human Ethical Committee and Institutional Research Committee Medical College, Thiruvananthapuram. Informed written consent was obtained from all study participants. Patients were given full freedom to exit the study at any time. Confidentiality was ensured and maintained throughout the study regarding data given by participants. No cost was incurred by the participants.

RESULTS
This study included 32 patients, of which 16 underwent CO_2 LTR and 16 underwent SMD. Preoperative assessment of symptoms showed that majority of participants exhibited moderate to severe nasal obstruction, with 43.8% having scores between 16 and 20, followed by 21.9% in the 21–25 range. Among them 40.6% had undergone medical management for 6 to 12 months prior to surgery. Preoperative Peak Nasal Inspiratory Flow (PNIF) values among participants demonstrated majority (37.5%) falling within the 31–40 L/min range and none of the subjects recorded PNIF values exceeding 60 L/min preoperatively.

None of the cases showed intraoperative bleeding in either group, demonstrating that both procedures were equally safe in terms of intraoperative haemostasis.

POST OPERATIVE SYMPTOM SCORE AT 1 MONTH

Table 1 Distribution of sample according to preoperative symptom score

Postop symptom score	SMD		LASER		Total		χ^2	df	p
	N	%	N	%	N	%			
5-10	0	0	7	43.8	7	21.9	15.06	3	0.002
11-15	8	50	9	56.3	17	53.1			
16-20	5	31.3	0	0	5	15.6			
21-25	3	18.8	0	0	3	9.4			
Total	16	100	16	100	32	100			

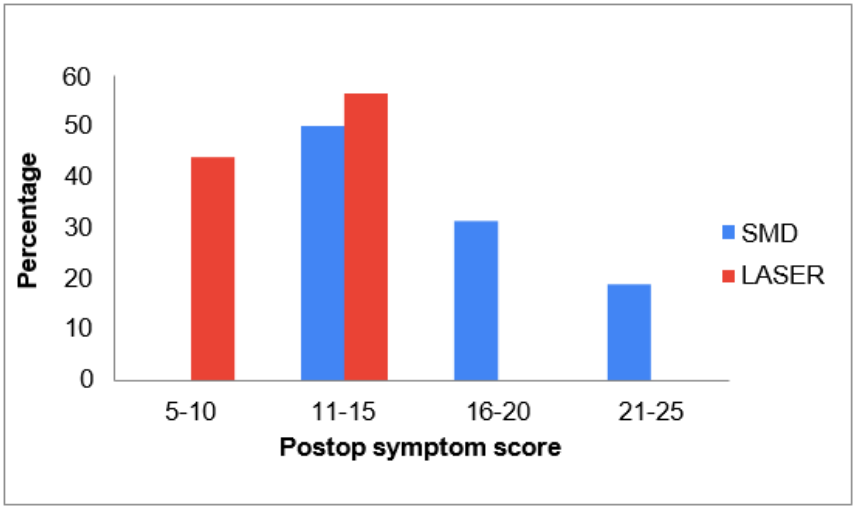

Figure 1

A significant difference was observed in postoperative symptom scores between the two groups at 1 month ($\chi^2 = 15.06$, df = 3, p = 0.002). In the LASER group, 43.8% had scores between 5 and 10, whereas none in the SMD group had scores in this range.

PNIF VALUE AT 1 MONTH

Table 2 Distribution based on Preoperative Peak Nasal Inspiratory Flow (PNIF) Scores

Postop PNIF at 1 month	SMD		LASER		Total		χ^2	df	p
	N	%	N	%	N	%			
36-45	1	6.3	0	0	1	3.1	9.8	6	0.133
46-55	1	6.3	0	0	1	3.1			
56-65	3	18.8	1	6.3	4	12.5			
66-75	1	6.3	0	0	1	3.1			
76-85	4	25	1	6.3	5	15.6			
86-95	4	25	6	37.5	10	31.3			
>95	2	12.5	8	50	10	31.3			
Total	16	100	16	100	32	100			

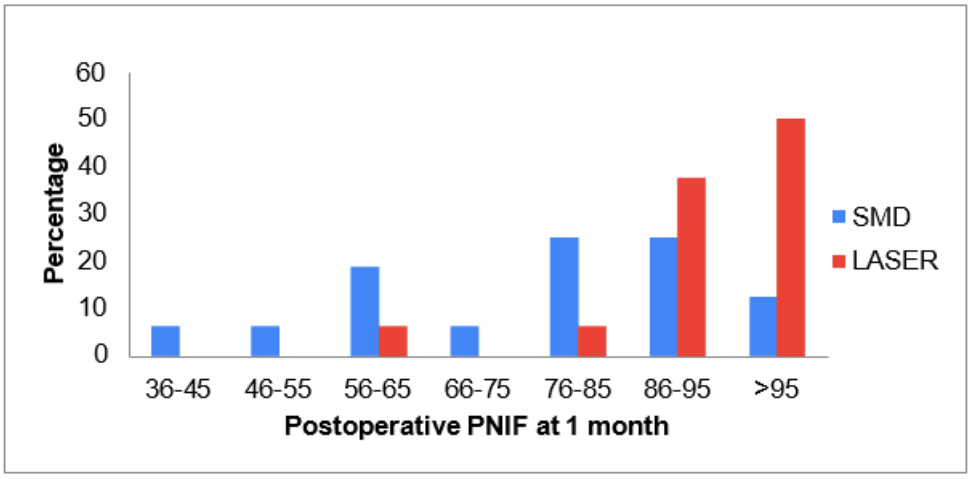

Figure 2

At 1 month postoperatively, 31.3% of participants had a PNIF value above 95 L/min, with a higher proportion in the LASER group 50% (8 patients) compared to the SMD group 12.5% (2 patients).

POSTOPERATIVE SYMPTOM SCORE AT 3 MONTHS

Table 3: Distribution based on Postoperative Symptom Score at 3 Months

Postop symptom score	SMD		LASER		Total		χ^2	df	p
	N	%	N	%	N	%			
5-10	10	62.5	15	100	25	80.6	6.975	1	0.008
11-15	6	37.5	0	0	6	19.4			
16-20	0	0	0	0	0	0			
21-25	0	0	0	0	0	0			
Total	16	100	15	100	31	100			

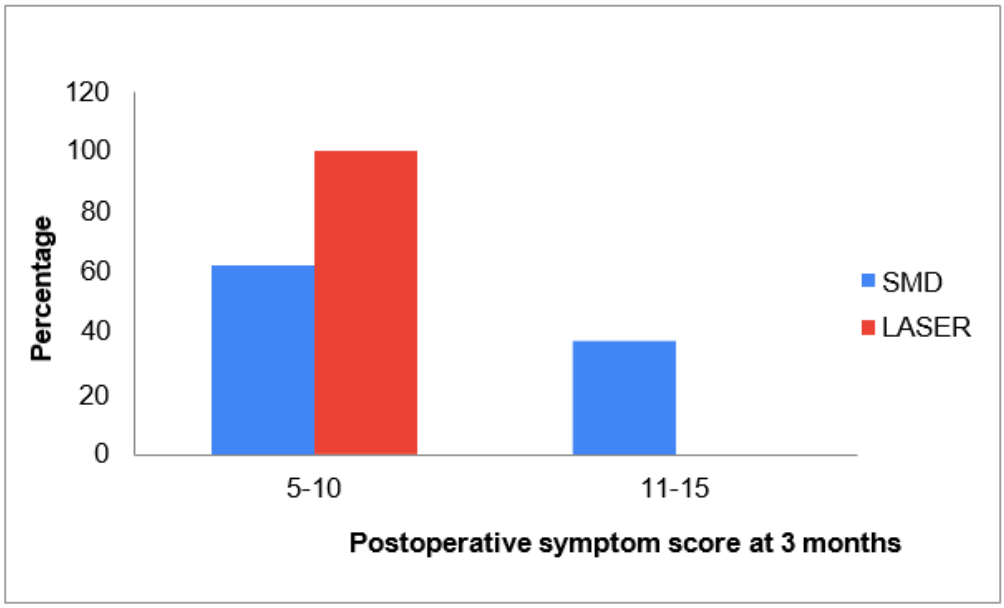

Figure 3

At 3 months, a significant difference was noted between the two groups ($\chi^2 = 6.975$, df= 1, p = 0.008). In the LASER group, all patients 100% (15 patients) had symptom scores in the range of 5–10, whereas 37.5% (6 patients) in the SMD group still had scores of 11–15. This suggests that LASER turbinate reduction provided better long-term symptom relief compared to SMD

POST OPERATIVE PNIF AT 3 MONTHS

Table 4: Distribution based on Postoperative PNIF at 3 Months

Postop PNIF at 3	SMD	LASER	Total		df	P

months	N	%	N	%	N	%	χ^2		
36-45	1	6.3	0	0	1	3.1	9.13	5	.104
56-65	1	6.3	0	0	1	3.1			
66-75	1	6.3	1	6.3	2	6.3			
76-85	4	25	0	0	4	12.5			
86-95	1	6.3	0	0	1	3.1			
>95	8	50	15	93.8	23	71.9			
Total	16	100	16	100	32	100			

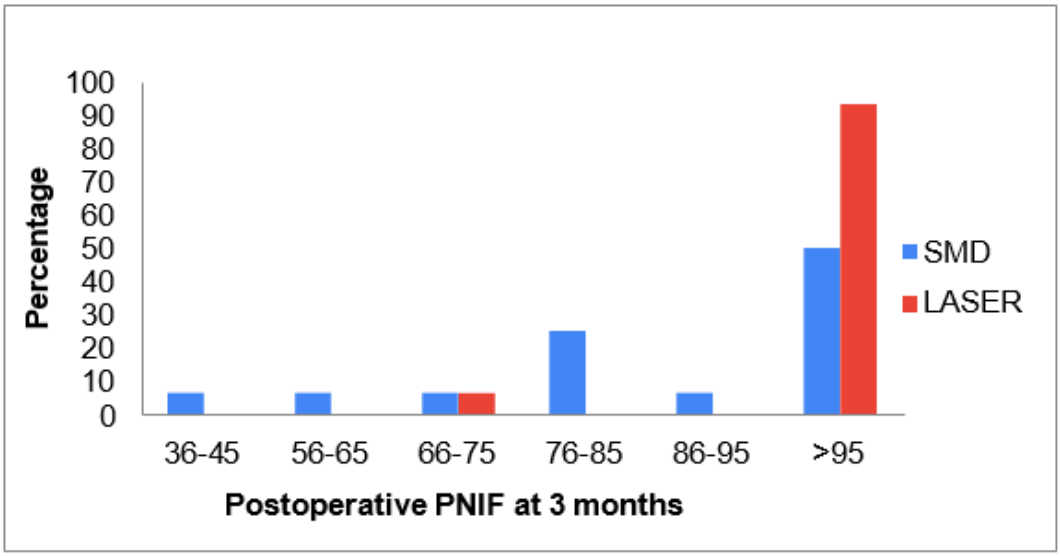

Figure 4

At 3 months, the majority of participants (71.9%) had PNIF scores above 95 L/min, with a higher proportion in the LASER group 93.8% (15 patients) compared to the SMD group 50% (8 patients).

POSTOPERATIVE CRUST FORMATION AT 1 MONTH

Table 5: Distribution based on postoperative crusting at 1 Month

Postop crust	SMD		LASER		Total		χ^2	df	p
	N	%	N	%	N	%			
Absent	9	56.3	14	87.5	23	71.9	3.865	1	0.049
Present	7	43.8	2	12.5	9	28.1			
Total	16	100	16	100	32	100			

Postoperative crusting was reported in 28.1% of participants. The incidence was significantly lower in the LASER group 12.5% (2 patients) compared to the SMD group 43.8% (7 patients), with a statistically significant difference ($\chi^2 = 3.865$, df = 1, p = 0.049).

POSTOPERATIVE CRUST FORMATION AT 3 MONTHS

Table 6: Distribution based on Postoperative Crusting at 3 Months

Postop crust score at 3 months	SMD		LASER		Total		χ^2	df	p
	N	%	N	%	N	%			
Absent	16	100	16	100	32	100	0	0	0
Present	0	0	00	0	0	0			
Total	16	100	16	100	32	100			

At the 3-month follow-up, no postoperative crusting was observed in either group, indicating that both surgical procedures resulted in complete mucosal healing by this time

PAIR WISE COMPARISON OF SYMPTOM SCORE DURING THE STUDY PERIOD

Table 7: Pair wise comparisons of symptom score during the study period

		SMD	LASER

Symptom score	N	EAN± SD	RANGE	EAN± SD	RANGE
Preoperative score	32	17.38±4.6	0-17	15.6±4.83	0-15
ative score 1 month	32	9.19±2.1	0-7	6.7±2.6	0-9
rative score 3 months	32	5.63±1.5	0-4	4.5±3.5	0-14

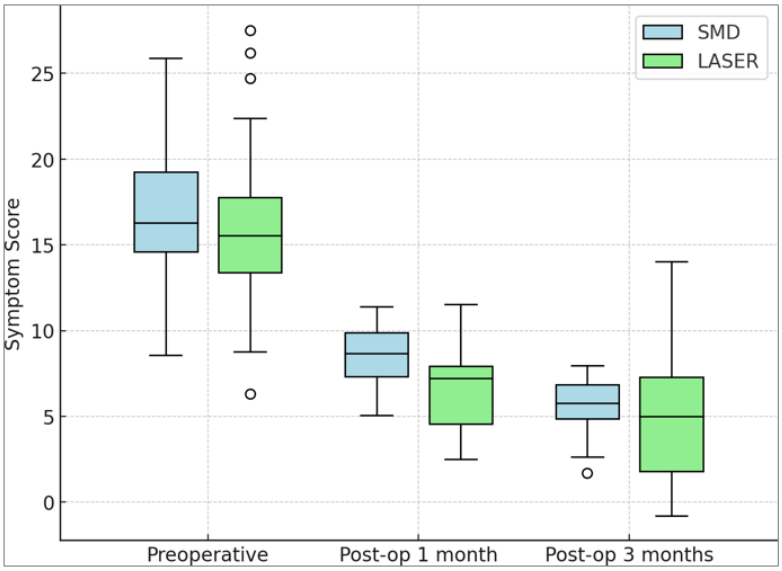

Figure 5

These results indicate both treatments were successful in alleviating symptoms

PAIR WISE COMPARISON OF PNIF VALUES DURING THE STUDY PERIOD

Table 8: Pair wise comparisons of PNIF values during the study period

PNIF value	N	SMD		LASER	
		MEAN±SD	RANGE	MEAN±SD	RANGE
Preoperative	32	35.9±9.5	0-40	44.4±11	0-30
Postoperative PNIF at 1 Month	32	76.8±17.7	0-60	97.06±17.4	0-70
Postoperative PNIF at 3 Months	32	88.19±19.7	0-70	106.2±15.3	0-75

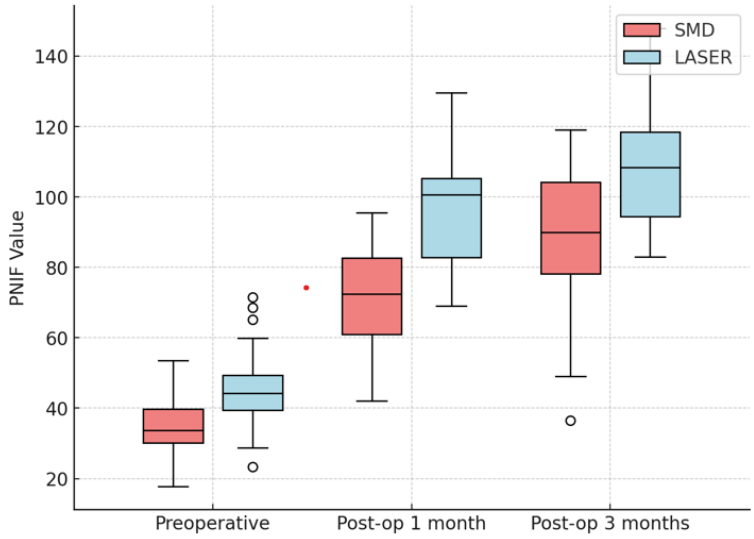

Figure 6

These findings suggest that both treatments significantly enhance nasal airflow postoperatively, with the LASER intervention demonstrating a more pronounced and sustained improvement in PNIF values over time during the follow up visits.

DISCUSSION

This prospective observational study compared the clinical outcomes of carbon dioxide laser turbinate reduction and

submucosal diathermy in patients with nasal obstruction due to inferior turbinate hypertrophy . The evaluation included both subjective assessments using the SF-36 symptom questionnaire and objective evaluation using Peak Nasal Inspiratory Flow (PNIF) measurements. The study aimed to provide comparative data to support surgical decision- making in the management of refractory ITH, a prevalent cause of chronic nasal obstruction.

The present study included 32 patients, evenly distributed between the two intervention groups. The majority (37.5%) were aged 18–28 years, followed by 34.4% in the 29–38 years group. This finding aligns with the demographic trend of ITH affecting young to middle-aged adults, similar to the studies by Lippert and Werner[2] (mean age 36.3 years) and Vijayakumar et al.[3] (34 years). Preoperatively, the majority of participants (43.8%) had symptom. scores between 16 and 20, suggesting a moderate level of nasal obstruction symptoms. A significant proportion (21.9%) had scores between 21 and 25, indicating more severe symptoms. These findings were comparable to Vinod Shinde et al[4]., who reported a mean preoperative score of 16.05 ± 4.69 for SMD and16.41 ± 5.04 for IT preoperatively. The highest proportion of participants (40.6%) had undergone medical treatment for 6-12 months. followed by 37.5% who had been treated for 3-6 months prior to surgery suggesting a more chronic or refractory condition.

Bilateral inferior turbinate hypertrophy was more frequent (78.1%). This pattern was similar to observations made by Gomaa et al[5]., who reported predominant bilateral hypertrophy in their surgical cohort.

Both CO_2 LTR and SMD demonstrated excellent intraoperative safety, with no cases of bleeding observed in either group, indicating that both techniques allow adequate hemostasis. At 1 month postoperatively, in the LASER group, a substantial proportion of participants (43.8%) had symptom scores between 5 and 10, indicating a marked improvement in their nasal obstruction symptoms. In contrast, none of the participants in the SMD group had scores in this range. This is in contrast to a study done by Vinod et.al[4] where postoperatively, after three weeks, the SMD showed a mean frequency of 5.00 ± 1.54. Similarly, PNIF scores improved substantially in the LASER group, with 50% of patients achieving values above 95 L/min, compared to 12.5% in the SMD group 'Study done by G. Ottaviano[6] on measurements of nasal airflow and nasal patency showed that PNIF is an important tool in the objective assessment of nasal obstruction.

Postoperative crusting was significantly lower in the LASER group (12.5%) than in the SMD group (43.8%) at 1 month. This correlates with findings from Lippert et al[2]., where CO_2 laser turbinectomy showed minimal crusting and faster mucosal recovery.

The assessment of symptom scores at 3 months postoperatively provided further insights into the long-term effectiveness of the two surgical techniques. In the LASER group, all patients (100%) had symptom scores in the range of 5-10, indicating sustained and excellent symptom relief. In contrast, a significant proportion of participants in the SMD group (37.5%) still had higher symptom scores of 11-15, suggesting less complete and longer-lasting relief. Study done by Pradipta Kumar Parida[7] on diode laser inferior turbinate reduction showed 86.7% patients had relief from nasal obstruction at 6months of follow up. Study The PNIF scores at 3 months postoperatively showed a higher proportion of participants in the LASER group (93.8%) had scores above 95 L/min compared to the SMD group (50%).

Mucosal healing was complete in both groups by 3 months, with no residual crusting, mirroring results by Vijayakumar et al[3]., where postoperative crusting resolved by the third month. Both procedures were better in terms of symptomatic improvement however the LASER group showed lower postoperative crusting, and a trend toward better nasal airflow improvement, both at 1 month and 3 months postoperatively Overall, the findings of this study are consistent with existing literatures that highlights the precision, minimal tissue trauma, and better nasal airflow improvement associated with laser-assisted techniques.

Future studies with larger sample sizes and longer follow-up durations could further clarify the durability of symptom improvement and the cost-effectiveness of these procedures

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