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Original Article

Ambiguity of Turbinate Surgery and Our Institutional Practice

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ABSTRACT

Background: *Inferior turbinate hypertrophy is a common cause of chronic nasal obstruction, and a host of surgical procedures are available for its treatment. The optimum method is controversial due to conflicting outcomes and complications in different techniques.* ***Methods & Materials:*** *In this retrospective study, 1337 patients in the age range of 3-65 years with chronic inferior turbinate hypertrophy due to allergic rhinitis, rhinitis medicamentosa, and vasomotor rhinitis were evaluated from September 2015 to January 2024 at Jalalabad Rabeya-Medical College Hospital, Sylhet, Bangladesh and Ad-din Medical College Hospital, Mogbazar, Dhaka, Bangladesh. Patients underwent four different surgical procedures: sub-mucosal diathermy (SMD) (n=864), partial inferior turbinectomy (PIT) (n=427), CO_2 laser vaporization (n=21), and rhinoplasty (n=25) during the study period. The statistical analysis was done on SPSS v26.0 and the p<0.05 was considered significant.* ***Results:*** *SMD was the most frequently carried out procedure (64.6%), followed by PIT (31.9%). PIT was associated with higher complication rates in the elderly, with 20% post-operative bleeding and 35% atrophic rhinitis. CO_2 laser vaporization was associated with the highest recurrence rate (80%), while PIT and turbinoplasty had improvement rates of up to 93% for allergic and vasomotor rhinitis. SMD was the most cost-effective, while CO_2 laser was the most expensive. Concomitant septoplasty was performed in 41.1% of SMD and 55.0% of PIT.* ***Conclusion:*** *Turbinate surgery method must be individualized based on patient factors, etiology, and economics. PIT and turbinoplasty provided superior long-term outcomes but higher complication rates, while SMD provided a better safety profile and was cost-effective.*

Keywords: *Inferior turbinate surgery, inferior turbinectomy, sub-mucosal diathermy, Turbinoplasty*

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INTRODUCTION

Chronic nasal obstruction is also one of the most frequent referral indications for otolaryngologists, significantly compromising patients' sleep and overall quality of life [1]. Besides other etiologies, inferior turbinate hypertrophy is a major cause, especially if medical management that is conservative does not decrease symptoms. Inferior turbinate hypertrophy can be due to etiologies such as allergic rhinitis, vasomotor rhinitis, and rhinitis medicamentosa, which result in chronic nasal obstruction [2]. The most protruding of all the nasal elements are the inferior turbinates, therefore extremely responsive to hypertrophic alterations according to their anatomical and physiological characteristics [3]. It is at the cost of nasal airway patency that causes a sensation of nasal stuffiness and respiratory discomfort while breathing through the nose. The treatment of inferior turbinate hypertrophy has evolved significantly over the decades. The primary focus of treatment is to relieve obstruction while preserving the physiological function of nasal mucosa, i.e., humidification, filtration, and warming [4]. Previous surgeries like total turbinectomy could eliminate the obstructing tissue but at the expense of significant complications such as atrophic rhinitis, crusting, and paradoxical nasal stuffiness, which greatly impaired patient comfort and nasal function [5]. These shortcomings prompted the development of more conservative surgical methods that did not seek to diminish turbinate size while preserving mucosal integrity. All the current surgical procedures for inferior turbinate hypertrophy include sub-mucosal diathermy (SMD), partial inferior turbinectomy (PIT), laser turbinate reduction, and turbinoplasty, each with inherent merits and limitations [6]. Sub-mucosal diathermy, for example, is a tissue-sparing operation that cauterizes submucosal tissue selectively but preserves intact the overlying mucosa and underlying bone. Sub-mucosal diathermy reduces turbinate volume by creating controlled fibrosis and tissue shrinkage preserves mucosal function intact and reduces postoperative morbidity [7]. These advancements illustrate a trend towards targeted intervention to maximize nasal breathing with nasal physiology maintained in consideration, offering symptomatic relief to patients with fewer side effects. This study aimed at utilizing the production of controlled fibrosis and volume reduction with minimal ciliary function impairment. Partial inferior turbinectomy, in contrast, is the surgical resection of some turbinate tissue,

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from one-third to subtotal resection, depending on the grade of hypertrophy and the surgeon's preference [8]. Assisted laser techniques, i.e., CO_2 laser vaporization, offer precise tissue ablation with putative advantages of reduced bleeding and healing time, even though their long-term efficacy is a matter of debate [9]. Turbinoplasty is a newer method that optimally weighs tissue removal against reconstruction to achieve optimal functional and esthetic outcomes [10]. The selection of appropriate surgical methods remains controversial, and there are not many comparative studies to provide good counsel in support of clinical decision-making [11]. The choice of technique depends on parameters like patient age, causative etiology, and magnitude of hypertrophy, concomitant nasal disease, surgeon's experience, and cost considerations [12]. Further, the role of concurrent procedures like septoplasty in optimizing outcomes makes planning surgery more complex [13]. This study may provide a structured comparative analysis of different inferior turbinate surgical techniques in a population of patients, comparing clinical outcomes, complications, recurrence, and economic factors in order to guide evidence-based surgical choice in clinical practice.

METHODS & MATERIALS

In this retrospective analysis, 1337 patients aged 3-65 years with chronic inferior turbinate hypertrophy due to allergic rhinitis, rhinitis medicamentosa, and vasomotor rhinitis were analyzed between September 2015 to January 2024 at Jalalabad Rabeya-Medical College Hospital, Sylhet, Bangladesh and Ad-din Medical College Hospital, Mogbazar, Dhaka, Bangladesh. These patients had persistent mechanical nasal obstruction that was not responding to treatment. Surgeries included sub-mucosal diathermy (SMD, n=864), partial inferior turbinectomy (PIT, n=427), CO2 laser vaporization (n=21), and turbinoplasty (n=25). The pre-operative assessment confirmed nasal obstruction by anterior rhinoscopy and endoscopy with enlarged turbinates occupying over one-third of the nasal lumen, with thick and pale mucosa and positive Cottle's sign. The SMD subgroup was stratified by the number of points cauterized (two, three, or four), while PIT was stratified by the percentage of resected tissue (one-third, two-thirds, or subtotal). CO2 laser vaporization subgroups were classified by the power of the laser (2-5 Watts). Septoplasty was done simultaneously in some patients with SMD (n=355) and PIT (n=235) and were compared to isolated procedures. The outcomes were compared in terms of demographic, environmental, socioeconomic, pathological, and technical variables. Follow-up after operation was 3 to 36 months to assess complications like persistent atrophic rhinitis and prolonged nasal obstruction, by olfactory testing, Cottle's test, and clinical examination. Economic analysis cost in Libyan dinars and US dollars in terms of medications, equipment, hospitalization, and follow-up. Data analysis used SPSS v26 with descriptive statistics, Chi-square, ANOVA, Student's t-test, and contingency coefficients; the significance level was $p<0.05$.

RESULTS

Table I shows the baseline clinical and demographic details of the entire study population of 1337 patients. All the patients belonged to the age group 3-65 years and had reported chronic nasal obstruction that was non-responsive to proper medical management. The etiology of turbinate hypertrophy was equally inflammatory causes like allergic rhinitis, vasomotor rhinitis, and rhinitis medicamentosa. Preoperative diagnosis was consistent among all the patients, and clinical inclusion criteria consisted of inferior turbinates occupying more than one-third of the nasal lumen, common pale and swollen mucosal appearance, and a positive Cottle's sign for functional nasal obstruction. Adopting a common diagnostic protocol ensures inter-study comparability of different surgical techniques and validates the indication for surgery in the study population.

Table – I: Study Population by Age, Indication, and Etiology (*n* = 1337)

Variable	Category/Details	Frequency (n)	Percentage (%)
Age Range	3 – 65 years	1337	100%
Indication for Surgery	Persistent nasal obstruction unresponsive to medical therapy	1337	100%
Etiology of Turbinate Hypertrophy	Allergic rhinitis, rhinitis medicamentosa, vasomotor rhinitis	1337	100%
Diagnosis (Pre-operative)	>1/3 nasal lumen blockage, pale thick mucosa, positive Cottle's sign	1337	100%

Table II represents the distribution of surgical methods indicating a clear hierarchy of preference in practice. Sub-mucosal diathermy (SMD) was most frequently used at 64.6% (n=864), reflecting its widespread usage based on relative safety and technical simplicity. Partial inferior turbinectomy (PIT) was second most frequently used at 31.9% (n=427), illustrating that it is still relevant despite added invasiveness. The newer techniques showed low use, with turbinoplasty done in 1.9% (n=25) and CO_2 laser vaporization in 1.6% (n=21) of the cases. The use pattern suggests prevalent clinical practice with tried-and-tested techniques, possibly due to surgeon familiarity, equipment availability, and perceived risk-benefit ratios. Low percentages of laser and turbinoplasty technique use could be a reflection of their relatively recent advent and associated learning curves.

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Table – II: Distribution of Patients by Surgical Technique (*n* = 1337)

Surgical Technique	Frequency (n)	Percentage (%)
Sub-Mucosal Diathermy (SMD)	864	64.6%
Partial Inferior Turbinectomy (PIT)	427	31.9%
CO_2 Laser Vaporization	21	1.6%
Turbinoplasty	25	1.9%
Total	1337	100%

Table III denotes the systematic technique standardization in all surgical classes. In SMD, patients were allocated equally to three sub-groups based on the cauterization points (2, 3, or 4 points), each covering approximately 33.3% of SMD cases (n=288 each). PIT patients were also allocated based on resection extent: one-third (PIT-A, n=142), two-thirds (PIT-B, n=142), and subtotal resection (PIT-C, n=143). CO2 laser patients were stratified according to power settings 2-5 watts and exhibited relatively uniform distribution by power level. The sub-classification permits the availability for detailed analysis of technique-specific factors and their impact on outcome. Uniform distribution within sub-groups suggests randomized assignment or systematic rotation of the techniques, which provides robust data for comparative analysis of technical differences between each of the broad surgical methods.

Table – III: Distribution of Patients According to Sub-Groups within Surgical Techniques

Technique	Sub-Group	Criteria	Frequency (n)	Percentage (%)
SMD	SMD-2 Points	Two cauterization points	288	33.3%
	SMD-3 Points	Three cauterization points	288	33.3%
	SMD-4 Points	Four cauterization points	288	33.3%
PIT	PIT-A	One-third resection	142	33.3%
	PIT-B	Two-thirds resection	142	33.3%
	PIT-C	Subtotal resection	143	33.4%
CO_2 Laser	Laser-1	2 Watts	5	23.8%
	Laser-2	3 Watts	5	23.8%
	Laser-3	4 Watts	6	28.6%
	Laser-4	5 Watts	5	23.8%

Table IV scrutinizes significant differences in septoplasty application across procedures. 41.1% (n=355) of SMD patients underwent concomitant septoplasty compared to 58.9% (n=509) who underwent isolated SMD. PIT patients showed higher septoplasty utilization at 55.0% (n=235) compared to 45.0% (n=192) who underwent isolated PIT. This difference suggests that PIT is undertaken more in individuals with coexistent turbinate hypertrophy and septal deviation, and possibly more severe nasal obstruction where comprehensive surgical correction is required. The high septoplasty rate among PIT patients is also likely to be evidence of surgical philosophy bias, where surgeons who perform more invasive turbinate surgeries are more likely to address concomitant septal disease. This information is useful in providing insight into trends in real-world surgical decision-making and for assessing the impact of septoplasty on turbinate surgery outcomes.

Table – IV: Effect of Concomitant Septoplasty on SMD and PIT

Technique	With Septoplasty (n)	Without Septoplasty (n)	Total (n)	% with Septoplasty
SMD	355	509	864	41.1%
PIT	235	192	427	55.0%

Table V outlines the detailed follow-up and evaluation protocol that was utilized in this study. Systematic assessment for early complications, i.e., nasal bleeding in the first week after operation, was conducted in all 1337 patients to present standardized short-term safety evaluation. Extended follow-up was from 3-36 months and was directed towards the two key problems of turbinate surgery: recurrence or persistence of nasal obstruction and development of atrophic rhinitis. The same criteria being applied uniformly to all the patients regardless of technique ensures confident comparison. The longer follow-up time frame records both late and intermediate outcomes, creating clinically relevant data for technique selection. This systematic approach identifies the most clinically significant complications and outcome measures known from turbinate surgery literature, making it possible to assess each technique's safety profile and effectiveness.

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Table – V: Postoperative Evaluation and Follow-Up

Evaluation Criteria	Timeframe	Applied To (n)	Percentage (%)
Nasal bleeding	First postoperative week	1337	100%
Recurrence/Persistence of obstruction	3–36 months	1337	100%
Atrophic Rhinitis	3–36 months	1337	100%

The analysis of Table VI reveals stark age-related complication trends, particularly for PIT. Older patients undergoing PIT reported significantly higher rates of postoperative hemorrhage (20%, approximately 85 patients) and atrophic rhinitis development (35%, approximately 149 patients) compared to younger patients. These findings are statistically significant (P<0.05) and indicate that PIT's more aggressive tissue removal method may be particularly deleterious in the elderly patient, who can presumably tolerate diminished healing ability and nasal physiology alteration. Alternatively, SMD and CO_2 laser approaches were noted to possess lesser complications in elderly patients, indicating enhanced safety profiles in this risk population. This information has direct clinical implications regarding technique selection in surgery, particularly in elderly patients where tissue preservation tactics may be best. The age patterns for complications indicate that the demographics of the patient are crucial in surgical planning.

Table – VI: Correlation between Technique, Age, and Early Post-Operative Complications

Technique	Complication	Age Group	Incidence (%)	Frequency (n)	Significance (P-value)
PIT	Post-op bleeding	Elderly	20%	~85	P < 0.05
PIT	Atrophic rhinitis	Elderly	35%	~149	P < 0.05
SMD / CO_2 Laser	Bleeding / Atrophy	Elderly	Lower incidence	—	P < 0.05

Table VII reveals stark differences in techniques and establishes key risk factors. CO_2 laser vaporization yielded the greatest recurrence rate of 80% (approximately 17 patients) challenging its long-term efficacy notwithstanding its theoretical advantages. SMD yielded middle-range recurrence rates of 30% (approximately 260 patients), whereas PIT showed low recurrence rates. The smoking and allergic exposure were found to be risk factors across all techniques (P<0.05), necessitating control of underlying inflammatory mechanisms and habits. The higher recurrence rate with CO_2 laser may be attributed to suboptimal reduction of tissue volume or premature re-epithelialization without sufficient fibrosis. From the results, it can be seen that patient counseling against smoking and allergen exposure is essential to maximize surgical outcomes, and selection of technique should consider intrinsic risk factors.

Table – VII: Recurrence of Inferior Turbinate Hypertrophy and Correlated Risk Factors

Technique	Population Risk Factors	Recurrence Rate (%)	Estimated n	Significance (P-value)
SMD	Smoking / allergic exposure	30%	~260	P < 0.05
CO_2 Laser	Smoking / allergic exposure	80%	~17	P < 0.05
PIT	Smoking / allergic exposure	Lower than others	—	P < 0.05

Table VIII demonstrates improved long-term improvement rates of PIT and turbinoplasty in treating allergic and vasomotor rhinitis, achieving up to 93% success rates (approximately 420 patients) with statistical significance (P<0.05). Such outstanding outcomes would be most likely due to greater tissue removal and architectural restructuring offered by these techniques. On the contrary, SMD and CO_2 laser demonstrated significantly lower improvement rates for these cases, suggesting that tissue-sparing techniques may be insufficient in patients with significant inflammatory burden. The similar success rates of PIT and turbinoplasty suggest that both tissue removal techniques can effectively correct the pathophysiology of inflammatory turbinate hypertrophy. These findings imply endorsement of disease-specific approach in technique selection, whereby patients with allergic or vasomotor rhinitis have a higher likelihood to benefit from tissue removal methods irrespective of their higher risk for complications.

Table – VIII: Long-Term Improvement Based on Patient Local Health Status

Condition	Technique	Improvement Rate (%)	Estimated n	Significance (P-value)
Allergic Rhinitis	PIT / Turbinoplasty	Up to 93%	~420	P < 0.05
Vasomotor Rhinitis	PIT / Turbinoplasty	Up to 93%	~420	P < 0.05
Allergic/Vasomotor	SMD / CO_2 Laser	Significantly less	—	P < 0.05

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The analysis in Table IX reveals considerable interactions among systemic comorbidities and surgical outcomes. Post-operative epistaxis was more frequent in the patients with uncontrolled hypertension who were treated with PIT (estimated 20-40 patients), due to the additive effects of greater tissue disruption and impaired hemostasis. Conversely, postoperative recurrence of nasal obstruction was more frequent in the patients with uncontrolled diabetes who underwent SMD or CO_2 laser (estimated 30-50 patients), perhaps reflecting impaired healing and chronic inflammatory processes. These findings underline the importance of pre-operative optimization of comorbidity profile and medical condition-based individualized choice of technique. The evidence suggests that tissue-conserving approaches should be offered to patients with cardiovascular disease or bleeding disorders and more intense tissue removal approaches for stable outcomes in diabetic patients.

Table – IX: Effect of General Health Status on Surgical Outcomes

Condition	Technique	Outcome	Estimated n	Significance (P-value)
Uncontrolled Hypertension	PIT	↑ Post-op Epistaxis	~20–40	P < 0.05
Uncontrolled Diabetes	SMD / CO_2 Laser	↑ Recurrence of nasal obstruction	~30–50	P < 0.05

Table X denotes the operative time analysis that provides valuable information for procedural planning and resource use. Turbinoplasty took the most operative time, which is in accordance with its technical intensity and reconstructive nature. PIT had moderate time demands, striking a balance between effectiveness and acceptable surgical time. CO_2 laser vaporization took less operative time than turbinoplasty but more than SMD, perhaps because of equipment preparation and strict tissue ablation need. SMD took the shortest operative time, also validating its known technical ease and efficacy. These time differences have significant implications for operating room utilization, surgeon fatigue, anesthesia time, and total healthcare costs. The statistical significance ($P<0.05$) of these differences attests to their clinical relevance and warrants consideration of operative efficiency in technique selection decision-making, particularly in high-volume practice.

Table – X: Intraoperative Time Consumption by Technique

Technique	Relative Time Consumption	Significance (P-value)
Turbinoplasty	Longest	P < 0.05
PIT	Moderate	P < 0.05
CO_2 Laser Vaporization	Shorter than Turbinoplasty	P < 0.05
SMD	Shortest	P < 0.05

Table XI shows the economic analysis which reveals significant cost differences between techniques with statistical significance ($P<0.05$). CO_2 laser vaporization was the most expensive procedure, primarily due to equipment costs, specialized training requirements, and maintenance. Turbinoplasty was the second most expensive, owing to technical complexity and longer operative time. PIT had moderate expenses, with straightforward equipment but moderate procedure complexity. SMD was the least expensive with low equipment requirements, brief operative times, and minimal post-operative care needs. These economic differences are particularly relevant in resource-limited settings and to healthcare policy development. The cost-effectiveness of SMD, as well as its safety profile, would help warrant frequent utilization in clinical practice. The economics, nevertheless, should be balanced with efficacy and long-term results in decisions regarding technique selection.

Table – XI: Economic Comparison Between Techniques (Estimated in USD)

Technique	Economic Cost Level	Estimated Rank	Significance (P-value)
CO_2 Laser Vaporization	Highest	1st	P < 0.05
Turbinoplasty	Moderate to High	2nd	P < 0.05
PIT	Moderate	3rd	P < 0.05
SMD	Lowest	4th	P < 0.05

DISCUSSION

This massive review of 1337 patients undergoing inferior turbinate surgery provides valuable information regarding the comparative effectiveness, safety, and cost considerations of different operative methods. The routine use of sub-mucosal diathermy (64.6%) in practice confirms its established safety and ease of performance of the technique, supporting a previous study demonstrating excellent results with tissue-conserving techniques [14]. Our findings show important caveats that invalidate the absolute application of each method. The greater long-term efficacy of partial inferior turbinectomy and turbinoplasty, with 93% curative rates in allergic and vasomotor rhinitis, is in agreement with physiological considerations that sufficient reduction in tissue

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volume is necessary for long-term relief from symptoms [15]. This is supported by the observations of Passàli et al., who reported superior long-term outcomes with procedures involving the removal of tissue compared to conservative treatments [16]. The mechanism of such success would most likely involve the removal of hypertrophied submucosal tissue and the interruption of neurogenic pathways leading to vasomotor instability [17]. Alternatively, the shocking 80% recurrence rate being reported with CO_2 laser vaporization puts its clinical utility into doubt to a large extent. This outcome deviates from earlier optimistic reports but parallels a recent systematic review by Acevedo et al. doubting the long-term efficacy of laser-assisted surgeries [18]. The high rate of recurrence can be attributed to a failure in the reduction of tissue volume, as laser vaporization is superficial and leaves behind deep submucosal structures that contribute to turbinate bulk [19]. Technical challenges in achieving optimal thermal control to cause desired laser effects may also lead to suboptimal effects in the tissue [20]. The age-related complication patterns identified in this study have important clinical implications. The increased incidence of postoperative bleeding (20%) and atrophic rhinitis (35%) among elderly patients with PIT suggests that aggressive tissue removal can be overwhelming to compensatory mechanisms in the older population. Nasal physiologic alterations with aging, including impaired mucociliary clearance and altered patterns of tissue healing, may predispose elderly patients to morbidity following massive turbinate manipulation [21]. These facts explain more conservative practices in elderly patients, as agreed with principles of geriatric surgery with a focus on tissue conservation. The identification of smoking and allergen exposure as high-risk factors for recurrence in all the methods underscores the importance of addressing underlying pathophysiology. Smoking impairs mucociliary function and promotes chronic inflammation, while ongoing allergen exposure maintains the inflammatory cascade driving turbinate hypertrophy. These findings suggest that surgical correction needs to be supplemented by meticulous medical treatment and lifestyle modification to optimize outcomes [22]. The impact of systemic comorbidities on surgical outcomes places a strong need for individualization of treatment. The increased risk of bleeding in patients with hypertension and the use of PIT is the interaction of tissue injury and deranged hemostasis, while increased recurrence in diabetic patients with the use of conservative methods can be explained by impaired wound healing and persistent inflammatory responses [23]. The results justify pre-operative medical improvement and technique selection according to comorbidity [24]. Our economic analysis recognizes important cost differences that extend beyond the cost of the procedure in the first phase. Although the CO_2 laser vaporization has the highest upfront expenditure, the 80% recurrence rate also necessitates repeat procedures quite often, further raising long-term expenditures. On the other hand, SMD's cost-effectiveness must be balanced against the lower recurrence rate of 30%, which can require repeat interventions. The economic benefit of rhinoplasty and PIT is evident in comparing their higher long-term efficacy and reduced rate of revision surgeries [25]. The role of concomitant septoplasty in optimizing outcomes is recorded, with 55% of PIT patients having combined procedures compared to 41% of SMD patients. It could be evidence of either patient selection bias or variable surgical philosophies but emphasizes the importance of correcting related nasal pathology to achieve the optimal outcome. The higher incidence of septoplasty among PIT patients may also reflect more severe initial obstruction requiring total surgical correction.

Limitations of the study

This retrospective study may give rise to selection bias and limit control for confounding factors that could influence surgical outcomes. The unequal distribution of technique, such that SMD represents 64.6% of cases and CO_2 laser only 1.6%, is likely to influence statistical power and comparability of less common techniques.

CONCLUSION

This retrospective study's comparative analysis establishes that the choice of surgical procedure for inferior turbinate hypertrophy needs to be individually customized based on patient population, causative etiology, comorbid burden, and cost. Although partial inferior turbinectomy and turbinoplasty offer higher long-term cure rates of 93% in allergic and vasomotor rhinitis, these are burdened with higher complication risks, particularly in geriatric patients. Sub-mucosal diathermy offers the optimal balance of safety and cost-effectiveness but with moderate recurrence rates, while CO_2 laser vaporization has a poor place in the clinic because of high recurrence rates despite theoretical advantage.

RECOMMENDATIONS

Subsequent studies should be directed at conceptualizing hybrid surgery methods that combine the safety of tissue-sparing and the efficacy of tissue-excising techniques. Furthermore, future prospective randomized trials with standardized endpoints and long-term follow-up are needed to generate technique-specific evidence-based recommendations for patient selection

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