REVIEW ARTICLE

Radiofrequency ablation vs. microdebrider-assisted turbinoplasty in chronic nasal obstruction: a systematic review and meta-analysis

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ABSTRACT

Chronic nasal obstruction caused by inferior turbinate hypertrophy is common; thus, surgical intervention is needed when medical treatments fail. Microdebrider-assisted turbinoplasty (MAT) and radiofrequency ablation (RFA) represent two minimally invasive approaches, yet their comparative long-term efficacy and safety remain subject to debate. This systematic review and meta-analysis aimed to compare the effectiveness of MAT and RFA in improving both objective and subjective measures of nasal obstruction, as well as to evaluate their respective safety profiles. The search was conducted in accordance with the PRISMA2020 guidelines across PubMed, Scopus, and Web of Science for randomized controlled trials (RCTs) published in the last ten years. The studies included were those that compared MAT and RFA in adults with turbinate hypertrophy. The analysis of the included RCTs showed that both MAT and RFA provided significant and comparable short-term improvements (3-12 months) in objective nasal airflow and subjective nasal obstruction. However, long-term data (up to 3 years) indicated that MAT resulted in superior outcomes, including greater improvement in nasal patency and a significantly lower rate of disease recurrence. The safety profiles of the two techniques also varied; RFA was associated with prolonged postoperative crusting, while MAT had a higher incidence of intra-operative bleeding. In conclusion, both MAT and RFA are effective treatments for inferior turbinate hypertrophy. For patients looking for a more durable long-term solution, MAT is recommended due to its superior efficacy and lower recurrence rates. Clinical decisions should be customized based on patient preference and a thorough discussion of specific risk profiles.

Keywords: Chronic nasal obstruction, inferior turbinate, microdebrider-assisted turbinoplasty, nasal turbinate, radiofrequency ablation.

Introduction

Inferior turbinate hypertrophy (ITH) represents a prevalent clinical condition and a leading cause of chronic nasal obstruction, frequently prompting patients to seek specialist otolaryngology consultation [1]. The inferior turbinates are essential for physiological nasal functions, including the regulation of inspiratory airflow resistance, as well as the filtration, warming, and humidification of air before it reaches the lower respiratory tract. Pathological enlargement of these structures, stemming from both allergic and non-allergic

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etiologies, significantly impedes nasal patency. This obstruction results in debilitating symptoms such as obligatory mouth breathing, oral mucosal dryness, altered nasal resonance, sleep disturbances, and a marked reduction in overall respiratory efficiency [2].

Initial management of ITH typically involves pharmacological interventions, including antihistamines, intranasal decongestants, and topical corticosteroids [3]. The primary objective of these treatments is to alleviate nasal congestion and facilitate comfortable physiological breathing [4]. However, when symptoms remain refractory to conservative medical therapy, surgical intervention becomes a necessary consideration. Throughout the years, various surgical techniques have been developed and implemented in clinical settings, including partial turbinectomy, submucosal resection, laser turbinoplasty, and cryosurgery [5,6]. These methods aim to reduce turbinate volume by inducing tissue fibrosis and scarring through the application of thermal or cold energy to the submucosal tissue [5].

Despite the multiplicity of available options, no universally accepted "gold standard" surgical technique has been established [7]. The best surgical approach must achieve a significant and durable reduction in nasal symptoms while meticulously preserving the histological structure and mucociliary function of the respiratory mucosa [8]. Many traditional aggressive procedures carry a substantial risk of injuring delicate mucosal tissues, potentially leading to complications such as crusting, bleeding, or atrophic rhinitis. Consequently, there has been a paradigm shift toward minimally invasive techniques that aim to maximize therapeutic benefits while minimizing collateral tissue damage.

Among these refined approaches, microdebrider-assisted turbinoplasty (MAT) and radiofrequency ablation (RFA)- also referred to as radiofrequency-assisted inferior turbinoplasty (RAIT)-have gained significant popularity. These techniques are favored for their ability to achieve submucosal volume reduction with lower complication rates and superior preservation of the nasal epithelium compared to conventional methods [9,10]. Previous literature has examined the efficacy of MAT and RFA, showing significant improvements in objective nasal airflow and subjective symptom scores [10]. However, existing reviews often face significant limitations, including a paucity of high-quality, long-term comparative meta-analytic data beyond 12 months and a reliance on a limited number of randomized controlled trials.

This lack of high-quality, long-term comparative evidence creates a significant research gap about the durability and late-stage safety profiles of MAT versus RFA. Therefore, the present systematic review and meta-analysis aim to provide a rigorous comparison of the long-term effectiveness of MAT and RFA in enhancing nasal patency and alleviating obstructive symptoms, specifically focusing on outcomes beyond the initial postoperative year. Additionally, we aim to systematically evaluate and compare the safety profiles and complication rates of both techniques to guide evidence-based clinical decision-making and emphasize the clinical necessity of durable surgical outcomes.

Methods

Study design and PRISMA statement

This systematic review and meta-analysis were formally performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.

Literature search strategy

A comprehensive literature review was conducted in the PubMed, Scopus, and Web of Science databases, covering the last ten years. The search utilized the following combination of keywords: ((radiofrequen* OR RFA OR "thermal ablation" OR "RF surgery" OR coblation OR electrocautery OR electrocoagulation) AND (turbin* OR "inferior turbinate" OR "nasal turbinate" OR microdebrider OR "submucosal resection") AND ("nasal obstruct*" OR "nasal congest*" OR "nasal blockage" OR "turbinate hypertroph*")).

Inclusion criteria

We specifically included randomized controlled trial (RCT) studies comparing RFA and MAT for chronic nasal obstruction caused by inferior turbinate hypertrophy in adults. Studies were required to report relevant clinical outcomes, such as nasal obstruction scores or postoperative complications.

Exclusion criteria

Studies were excluded if they involved other surgical techniques without a MAT or RFA comparator, non-randomized designs, non-comparative studies, reviews, case reports, animal studies, or publications in languages other than English.

Selection of articles and data extraction

Two reviewers independently screened titles and abstracts, followed by a full-text assessment for eligibility. Data were independently extracted using a predesigned Excel sheet, capturing author, year, country, sample size, participant characteristics, intervention details, follow-up duration, and key outcomes (objective airflow, subjective obstruction scores, quality of life, and adverse events). Any discrepancies between the two reviewers during the selection or extraction processes were resolved through discussion or, if necessary, by consultation with a third reviewer to reach a consensus.

Quality assessment

The Cochrane risk-of-bias tool for randomized trials (RoB 2) was used to assess the risk of bias (RoB) in the included studies [11]. The tool evaluates five critical domains: the randomization process, deviations from planned interventions, handling of missing outcome data, measurement of outcomes, and selection of reported results. Each study was classified as having low, some concerns, or elevated risk of bias.

Statistical analysis

Statistical analyses were performed using Review Manager (RevMan) version 5.4.1 (Cochrane Collaboration, Copenhagen, Denmark). Continuous data were expressed as standardized mean difference (SMD) and 95% confidence interval (CI). Statistical heterogeneity among the studies was assessed using I-squared (I^2) and chi-squared (Chi^2) statistics, where I^2 values ≥50% were indicative of significant heterogeneity.

Ethics statement

As this study is a systematic review based on previously published literature, formal ethical approval was not needed.

Results

Figure 1 illustrates the study selection process according to the PRISMA 2020 guidelines. A total of 747 papers were extracted from databases (PubMed, Web of Science, and Scopus). After screening and eligibility assessment, seven articles were considered suitable for the systematic review.

Table 1 summarizes the key characteristics of the seven studies included in the systematic review. The patient cohorts across all studies were broadly comparable in terms of mean age and gender distribution. The primary treatment site was consistently the inferior turbinates. Notably, a uniform approach was seen, particularly among studies conducted in Finland, which used the same Radiofrequency Ablation (RFA) device (Sutter generator) and Microdebrider (Medtronic Xomed) protocols. All procedures were performed under local anesthesia, ensuring a consistent comparison between the two intervention groups regarding patient experience and preoperative management. The sample sizes were moderate, and follow-up durations ranged from 3 months to 3 years.

Table 2 indicates that both radiofrequency ablation (RFA) and microdebrider-assisted turbinoplasty (MAT) are effective surgical techniques for treating chronic nasal obstruction caused by inferior turbinate hypertrophy. In the short term, both methods show significant and comparable improvements in objective nasal airflow, subjective patient-reported obstruction, and overall quality of life. However, in the long term, MAT may provide superior durability, with evidence suggesting it leads to greater improvement in nasal patency and a significantly lower rate of disease recurrence compared to RFA. The safety profiles of the two procedures also differ; RFA is commonly associated with a higher incidence of prolonged postoperative crusting, while MAT carries a greater risk of intraoperative bleeding.

Figure 2 shows the risk of bias (ROB2) for the included studies. The overall risk of bias among the included studies was low, with four out of seven trials achieving a low-risk rating across all domains. However, some concerns were raised for three studies, primarily due to potential biases arising from deviations from the intended intervention and the measurement of outcomes. Despite these concerns, the overall evidence base can be considered methodologically sound.

Figure 3 presents the forest plot for objective airflow measured by Acoustic Rhinometry (V2–5 cm). The analysis shows no significant difference between RFA and MAT, with a pooled standardized mean difference (SMD) of 0.15 [95% CI: –0.13, 0.43] ($P = 0.29$). The heterogeneity was low ($I^2 = 0\%$, $P = 0.79$), suggesting that both RFA and MAT are equally effective in improving objective nasal airflow in the intermediate term post-operation.

Figure 4 shows a forest plot analyzing changes in subjective nasal obstruction measured by a Visual Analog Scale (VAS), where higher scores indicate worse obstruction. The overall pooled SMD is 0.16, suggesting a very small, non-significant trend favouring Microdebrider-Assisted Turbinoplasty (MAT). The 95% confidence interval [–0.12, 0.45], ($P = 0.25$). The studies show no significant heterogeneity ($I^2 = 0\%$, $P = 0.50$), indicating consistency among results. In conclusion, RFA and MAT produce similar significant improvements in nasal obstruction with no clear superiority of one technique over the other.

Discussion

The current study evaluates the efficacy and safety of radiofrequency ablation (RFA) and microdebrider-assisted turbinoplasty (MAT) for treating inferior turbinate hypertrophy, based on seven randomized controlled trials. The pooled analysis demonstrates that both techniques yield significant improvements in objective nasal airflow (SMD 0.15; 95% CI: –0.13 to 0.43; $P = 0.29$) and subjective nasal obstruction (SMD 0.16; 95% CI: –0.12 to 0.45; $P = 0.25$) during short- to intermediate-term follow-up (3-12 months), with no statistically significant difference between procedures. However, long-term data extending to three years reveal clinically important distinctions. MAT provides superior durability in nasal patency improvement and a markedly lower disease recurrence rate (14.28% vs. 45.71%) compared to RFA. The safety profiles also diverge, with RFA associated with prolonged postoperative crusting and MAT carrying a higher risk of intraoperative bleeding.

Our findings align with and extend previous systematic reviews that have compared these techniques. Acevedo et al. [10] conducted a meta-analysis of five studies and similarly concluded that both RFA and MAT effectively reduce nasal obstruction, with comparable short-term outcomes. However, their analysis was limited by shorter follow-up durations and could not assess long-term durability. More recently, Mirza et al. [12] conducted a systematic review of 12 interventional studies and reported equivalent efficacy between techniques at 6-12 months, consistent with our pooled estimates, which show no significant differences in the intermediate term.

The superior long-term efficacy of MAT observed in our review corroborates the findings of Romano et al. [13], who proved that microdebrider-assisted techniques better preserve respiratory epithelium and promote favorable mucosal regeneration compared to energy-based ablation

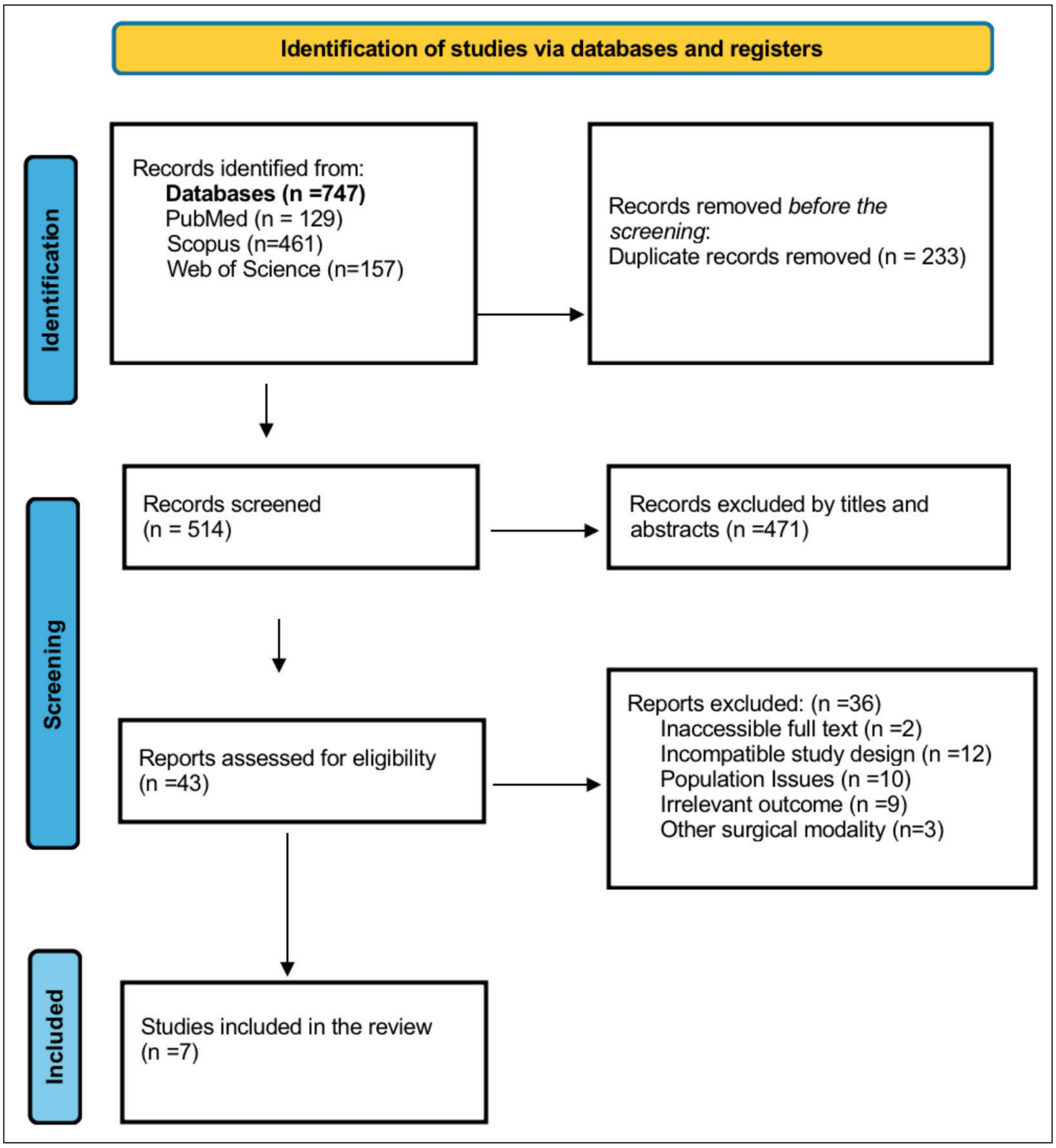

Figure 1. *PRISMA 2020 flow diagram illustrating the study selection process.*

methods. This histological advantage explains the sustained clinical improvement and lower recurrence rates associated with MAT. The mechanism underlying this difference relates to the immediate mechanical removal of submucosal tissue with MAT versus the delayed coagulative necrosis and fibrosis induced by RFA [14,13]. While RFA relies on secondary intention healing and scar contraction for volume reduction, MAT achieves immediate debulking with preservation of the overlying mucosal flap, thereby supporting physiological mucociliary function [15,16].

Our observation that RFA is associated with prolonged crusting (affecting up to 43% of patients at three months in one study) [17] corroborates earlier reports by Pelen et al. [18], who documented crusting persisting beyond eight weeks in 5% of RFA-treated patients. Conversely, the higher intraoperative bleeding risk with MAT (20% requiring nasal packing in some series) [17,18] reflects the more invasive nature of mechanical tissue resection and aligns with the findings of Zhang et al. [19] in their comprehensive review of turbinate surgeries.

The meta-analyses for both objective airflow ($I^2 = 0\%$) and subjective obstruction ($I^2 = 0\%$) proved negligible statistical heterogeneity, showing consistency in treatment effects across studies despite variations in patient populations and geographic settings. This homogeneity strengthens confidence in the pooled estimates and suggests that the comparative effectiveness of these techniques is reproducible across different clinical contexts.

However, several factors may explain the divergence between short-term equivalence and long-term superiority of MAT. First, the biological response to tissue injury differs fundamentally between modalities. RFA induces thermal coagulation necrosis that requires weeks for resolution and fibrosis development, while MAT provides immediate volumetric reduction through tissue extraction [14,13]. Second, the preservation of mucosal integrity with MAT may better support long-

Table 1. Characteristics of included RCT studies comparing Radiofrequency Ablation (RFA) and Microdebrider-Assisted Turbinoplasty (MAT).

Author name, year, and country	Total Sample Size, follow-up	Mean Age (SD) years	Gender (M/F)	Treatment site	RFA	MAT	Anesthesia
Maniaci et al., [15] in Italy and France (Multicenter)	106 patients RFA: 35 MAT: 35 CAT: 35 Follow-up: 3 years	RFA: 30.60 ± 5.21 years MAT: 33.05 ± 8.1 years	RFA: 16/19 MAT: 21/14	Inferior Turbinates	Radiofrequency-Assisted Turbinoplasty	Microdebrider-Assisted Turbinoplasty with a Straightshot M4 microdebrider blade at 5000 rpm.	Local (1% lidocaine with epinephrine 1:100,000).
Harju and Numminen, [20] in Finland	98 patients RFA: 25 MAT: 25 Diode laser: 28 Placebo: 20 Follow-up: 3 years	RFA: 45.3 MAT: 46.2	RFA: 12/13 MAT: 16/9	The medial side of the anterior half of the inferior turbinate in all groups.	Device: Sutter RF generator BM-780 II Probe: "Binner" bipolar needle electrode Technique: The probe is placed in submucosal tissue, using radiofrequency energy to create heat (< 85°C) that causes coagulative necrosis and contracts the tissue, reducing turbinate volume.	Device: Microdebrider system (Medtronic Xomed) Instrument: 2.9 mm rotatable microdebrider tip Technique: A powered shaver that cuts and aspirates soft tissue, resecting submucosal stroma while preserving the mucosal lining.	Topical: Cotton strips soaked in a mixture of Lidocaine 40 mg/ml and Epinephrine 0.1% (2-3 drops in 5-10 ml lidocaine). Local Infiltration: ~1.5 ml of Lidocaine 10 mg/ml with adrenaline 10 µg/ml injected into the medial portions of both inferior turbinates.
Harju and Numminen, [14] in Finland	50 patients RFA: 25 MAT: 25 Follow-up: 1 Year	NR	NR	Medial side of the anterior half of the inferior turbinates (bilaterally).	Device: Sutter RF generator BM-780 II. Technique: Bipolar needle electrode inserted submucosally. Treated for 6 sec at 10W in three areas of the anterior half.	Device: 2.9 mm rotatable microdebrider blade (Medtronic Xomed). Technique: Mucosal pocket dissected, stromal tissue resected at 3000 rpm with suction irrigation.	Local (lidocaine 40mg/ml + epinephrine).
Kankaanpää et al., [21] in Finland	98 patients RFA: 28 MAT: 28 Diode Laser: 28 Placebo: 14 Follow-up: 3 months	Median = 46 years (Range: 19-69)	56/42	Medial side of the anterior half of the inferior turbinate.	Device: Sutter RF generator BM-780 II. Technique: The bipolar needle electrode was inserted into the medial submucosal tissue of the inferior turbinate.	Device: Medtronic Xomed microdebrider. Technique: The microdebrider tip was firmly pushed toward the turbinate bone until it pierced the mucosa of the anterior face of the inferior turbinate.	Local Anesthesia (Lidocaine 40 mg/mL & 10 mg/mL with epinephrine)
Harju et al., [17] in Finland	98 patients RFA: 28 MAT: 28 Diode laser: 28 Placebo: 14 Follow-up: 3 months	Median = 46 years (Range: 19-69)	56/42	Medial side of the anterior half of the inferior turbinate (bilaterally).	Device: Sutter RF generator BM-780 II. Technique: Binner bipolar needle electrode inserted submucosally. Treated for 6 seconds at 10 W in three areas on the anterior half of the turbinate.	Device: Medtronic Xomed 2.9-mm rotatable microdebrider tip. Technique: Submucosal pocket dissected and stromal tissue resected at 3,000 rpm with suction irrigation.	Local anaesthesia (Lidocaine 40 mg/mL and 10 mg/mL with epinephrine)
Akagün et al., [22] in Turkey	40 patients RFA: 20 MAT: 20 Follow-up: 3 months	RFA: 33.10 ± 14.20 years MAT: 31.20 ± 11.31 years	RFA: 9/11 MAT: 12/8	Bilateral Inferior Turbinates	Device: Gyrus ENT Sonomotoplasty (Model 735000) Technique: Submucosal application to the ant, med, and inf parts of the turbinate (10mm active tip). 75°C, 8W, 450 J per site (total 1350 J).	Device: 4mm straight tru-cut microdebrider (XOMED Medtronic) at 3000 rpm. Technique: 4-5mm vertical incision, creation of submucosal tunnel, resection of submucosal tissue. Mucosal flap preserved. Nasal packing for 48h.	Local (1% lidocaine + 1:100,000 epinephrine)
Pelen et al., [18] in Turkey	40 patients RFA: 20 MAT: 20 Follow-up: 8 weeks	RFA: 40.55 ± 7.4 MAT: 36.75 ± 6.2	RFA: 9/11 MAT: 11/9	RFA: Submucosal application to the upper, middle, and lower parts of the inferior turbinate. MAT: Submucosal pocket in the inferior turbinate for tissue debridement.	Device: Ellman Surgitron FFPF EMC (Elman International Inc., USA). Technique: The active part of the device was placed into the turbinate. Applied in coagulation mode at power setting 3.5 (17 W). Applied to the upper, middle, and lower parts until blanching was observed or the device gave an acoustic warning (average 20 seconds).	Device: XPS 3000 Microdebrider (XOMED Medtronic, USA) with a 2.9 mm inferior turbinate blade. Technique: A vertical incision was made. A submucosal pocket was formed. The microdebrider was placed into this pocket, and submucosal tissues were debrided. Used in 3000 rpm mode.	Local Anesthesia: Infiltration of the inferior turbinate with approximately 4 mL of prilocaine to tumefy the turbinate medially.

CAT, coblator-assisted turbinoplasty; MAT, microdebrider-assisted turbinoplasty; NR, not reported; RFA, radiofrequency ablation; SD, standard deviation.

Table 2. *Summary of outcomes from included studies comparing Radiofrequency Ablation (RFA) and Microdebrider-Assisted Turbinoplasty (MAT).*

Author, year	Objective Airflow (Acoustic Rhinometry V2-5 cm, cm³)	Subjective Nasal Obstruction (VAS Score, 0-10) - Higher score = worse obstruction	Quality of Life (GHSI, 0-100)	Adverse Events	Conclusion
Maniaci et al., [15]	(Rhinomanometry RAA, Pa/cm³/s) 3-Year Post-op Value (Mean ± SD): • RFA: 0.59 ± 0.19 • MAT: 0.38 ± 0.06 MAT showed a statistically significantly greater improvement in nasal resistance compared to RFA at 3 years ($p < 0.001$).	3-Year Post-op Value (Mean ± SD): • RFA: 5.22 ± 1.92 • MAT: 3.05 ± 1.08 MAT resulted in a statistically significantly lower (better) VAS score for nasal obstruction at the 3-year follow-up ($p < 0.001$).	NR	Disease Recurrence Rate for 3 Years: • RFA Group: 45.71% (16/35 patients) • MAT Group: 14.28% (5/35 patients)	Long-term symptomatic stability varies depending on the type of turbinoplasty used. MAT demonstrated greater efficacy in controlling nasal symptoms, presenting better stability... In contrast, radiofrequency techniques were associated with a higher rate of disease recurrence, both symptomatically and endoscopically.
Harju and Numminen, [20]	Median (IQR) RFA Pre: 4.54 (3.16-5.71) 3 months: 5.81 (4.29-7.13) 3 year: 5.01 (4.04-5.87) Change compared to preoperative Median (IQR): 1.00 (−0.47 to 2.55) MAT Pre: 3.58 (2.55-4.64) 3 months: 4.24 (3.40-5.38) 3 year: 4.45 (3.36-6.36) Change compared to preoperative Median (IQR): 0.70 (0.19 to 1.21)	Median (IQR) RFA Pre: 7.0 (6.0-8.3) 3 months: 2.0 (1.0-3.5) 3 year: 3.0 (1.0-7.0) Change compared to preoperative Median (IQR) −5.0 (−7.0 to −3.0) MAT Pre: 8.0 (7.0-9.0) 3 months: 3.0 (1.8-4.0) 3 year: 3.0 (2.0-6.0) Change compared to preoperative Median (IQR) −6.0 (−6.3 to −3.0)	Mean (95% CI) RFA Pre: 55.7 (50.9-60.5) 3 months: 68.7 (63.8-73.6) 3 year: 70.1 (64.1-76.0) MAT Pre: 53.5 (48.0-59.0) 3 months: 68.3 (63.5-73.0) 3 year: 67.7 (62.2-73.2)	NR	The application of RFA, MAT, and diode laser treatments all resulted in notable improvements in patients' perceived severity of nasal blockage and quality of life. These positive effects were maintained during a follow-up period of three years for all three methods. While a decline in the objective effectiveness of RFA was observed over a longer follow-up, this did not affect the patients' subjective perceptions of their treatment outcomes.
Harju and Numminen, [14]	Non-decongested Volume (Mean Change from baseline, 95% CI): • RFA: +1.37 cm³ (0.16 to 2.59), p = 0.03 • MAT: +1.55 cm³ (0.21 to 2.88), p = 0.01	Mean Change from baseline (95% CI): • RFA: –3.9 (–5.2 to –2.7), $p < 0.001$ • MAT: –4.3 (–5.2 to –3.5), $p < 0.001$ Pre/Post Median (IQR): • RFA Pre: 8.0 (7.0-8.0); Post: 3.5 (2.0-5.0) • MAT Pre: 8.0 (7.0-8.0); Post: 2.8 (2.0-4.9)	NR	No major complications reported. Symptoms of crusting, discharge, and sneezing all improved significantly in both groups.	Both techniques are effective at reducing nasal obstruction and increasing nasal volume at 1 year. Turbinate contractility decreased to normal levels post-operatively. There was no deterioration in other nasal symptoms or mucociliary function.
Kankaanpää et al., [21]	NR	NR	(Mean, 95% CI) RFA: +12.5 (8.2 to 16.8) MAT: +14.9 (10.7 to 19.1)	NR	Both RFA and MAT significantly improved QOL, with no significant difference between them. However, only MAT provided a statistically significant additional QOL improvement compared to the placebo procedure.
Harju et al., [17]	RFA pre-operative: 4.39 (3.02 to 5.65) Post-operative: 5.39 (4.29 to 6.48) Change from baseline: 1.12 (–0.38 to 2.39) MAT Pre-operative: 8.0 (6.3 to 8.9) Post-operative: 2.0 (1.0 to 3.8) Change from baseline: –0.64 (20.27 to 1.56)	RFA Pre-operative: 8.0 (6.3 to 8.9) Post-operative: 2.0 (1.0 to 3.8) Change from baseline: –5.0 (–7.0 to –3.3) MAT Pre-operative: 8.0 (7.0 to 9.0) Post-operative: 3.0 (1.6 to 4.0) Change from baseline: –5.5 (–6.4 to –3.0)	NR	RFA Bleeding Requiring Nasal Packing: 1 Crusting at 3 Months: 12 patients (43% of the RFA group) had minor crusting. Other: A temporary increase in nasal discharge and crusting was noted in the first postoperative days. MAT Bleeding Requiring Nasal Packing: 5 at the outpatient clinic. Crusting at 3 Months: 2 patients (7% of the MAT group) had minor crusting. Synechia: 1	A notable placebo effect contributes significantly to the overall improvement in nasal obstruction following turbinate surgery. Techniques such as RFA, diode laser, and MAT have all demonstrated genuine effectiveness, showing a statistically significant reduction in the severity of nasal obstruction when compared to placebo treatments. However, at the three-month follow-up, no significant differences in efficacy were observed among the three surgical techniques.

Continued

Author, year	Objective Airflow (Acoustic Rhinometry V2-5 cm, cm^3)	Subjective Nasal Obstruction (VAS Score, 0-10) - Higher score = worse obstruction	Quality of Life (GHSI, 0-100)	Adverse Events	Conclusion
Akagün et al., [22]	Total Nasal Resistance ($Pa/cm^3/s$) at 150 Pa: A significant decrease in nasal resistance was found in both groups postoperatively compared to preoperative values.	Preop - > 3rd Month Postop (Mean ± SD): • MAT Group: 6.69 ± 1.67 - > 1.96 ± 1.83 • RFA Group: 5.99 ± 1.60 -> 4.69 ± 2.14 Statistical Note: The improvement was significantly greater in the MAT group at the 1st week, 1st month, and 3rd month post-op ($p < 0.05$).	NR	MAT Group: Expected post-op crusting (significant at 1st week), nasal packing for 48h. RFA Group: Increased edema and secretion at the 1st week. Both Groups: Mild postoperative pain, nasal congestion, and crusting. No major complications (e.g., bleeding, synechiae) were reported.	Both RFTA and MAT are effective techniques for treating inferior turbinate hypertrophy. The treatment modality should be individually determined, and parameters such as tissue healing, volume reduction, and mucociliary activity must be considered.
Pelen et al., [18]	RFA Pre-op: 3.90 ± 1.54 Post-op: 6.74 ± 2.58 Change: +2.79 ± 1.98 ($p < 0.01$) MAT Pre-op: 3.70 ± 1.32 Post-op: 6.17 ± 1.28 Change: +2.20 ± 1.11 ($p < 0.01$)	RFA Pre-op: 2.62 ± 0.62 Post-op (8 wk): 1.05 ± 0.63 Change: –1.57 ± 0.71 ($p < 0.01$) MAT Pre-op: 2.75 ± 0.70 Post-op (8 wk): 0.65 ± 0.62 Change: –2.10 ± 1.01 ($p < 0.01$)	NR	RFA Intra-op: Slight bleeding from injection sites (common). Post-op: Mild pain (50% of patients). Crusting (40%), persisting >2 weeks in 10% and >8 weeks in 5%. One case (5%) of turbinate bone necrosis with purulent discharge. MAT Intra/Post-op: Bleeding (20%, required packing). Mucosal tear (35%). Crusting (30%).	RFA is an effective technique for alleviating nasal obstruction and enhancing airflow, though it is characterized by a slower onset of subjective improvement, including potential worsening at day three, and carries a notable risk of crusting as well as rare but serious complications like bone necrosis. In contrast, MAT offers faster and significantly greater subjective improvement, along with enhanced airflow; however, it is associated with a higher incidence of intraoperative adverse events, such as bleeding and mucosal tears.

GHSI, general health status index; IQR, interquartile range; MAT, microdebrider-assisted turbinoplasty; NR, not reported; RFA, radiofrequency ablation; SD, standard deviation; VAS, visual analog scale.

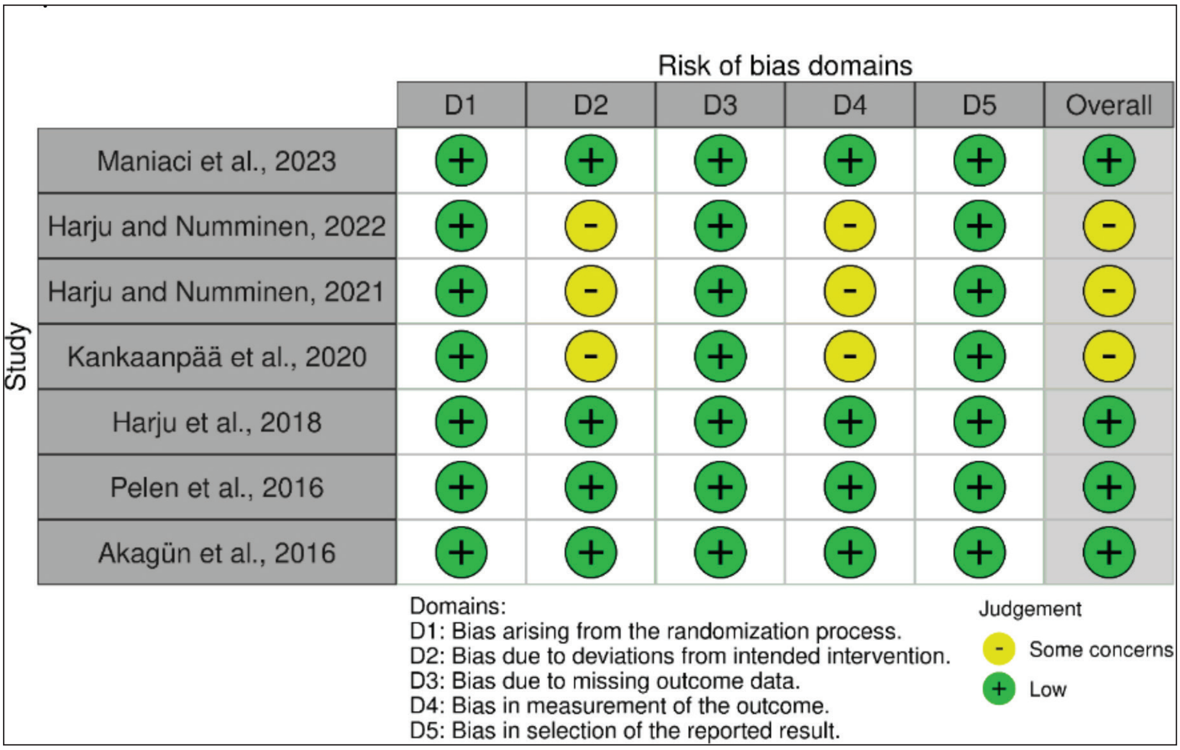

Figure 2. *Risk of bias assessment for included randomized controlled trials.*

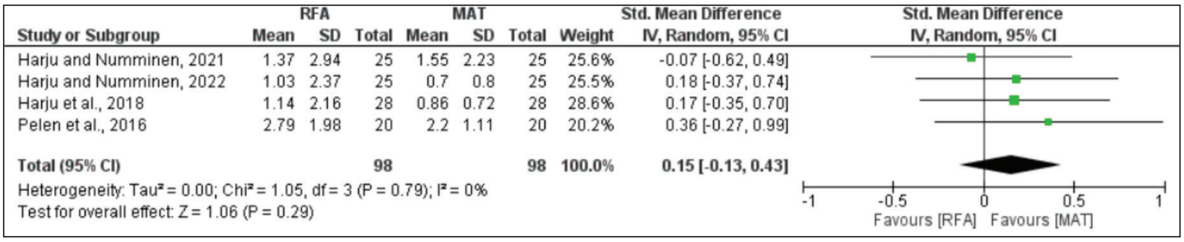

Figure 3. *Forest plot for objective airflow (Acoustic Rhinometry V2-5 cm) comparison between Radiofrequency Ablation and Microdebrider-Assisted Turbinoplasty.*

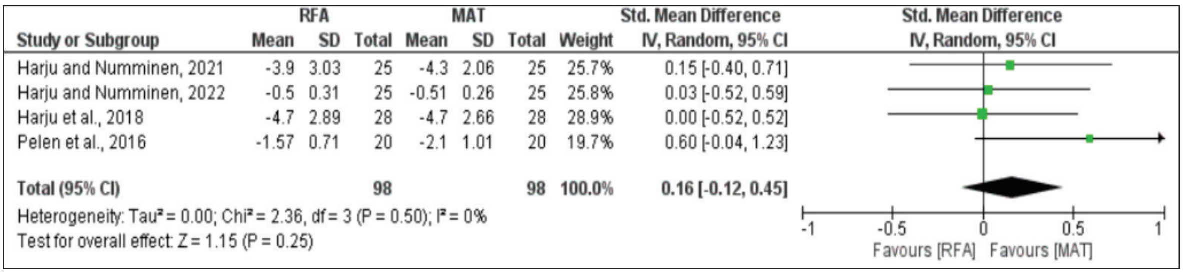

Figure 4. *Forest plot change in subjective nasal Obstruction (VAS Score) from baseline for Radiofrequency Ablation vs. Microdebrider-Assisted Turbinoplasty.*

term nasal physiology, as intact respiratory epithelium is essential for mucociliary clearance and prevention of crust formation [16]. Third, the recurrence pattern seen with RFA reflects incomplete or variable tissue destruction, as thermal energy delivery can be inconsistent depending on tissue impedance and probe placement [15].

Notably, the three-year follow-up data from Maniaci et al. [15] revealed progressive deterioration in RFA-treated patients between 12 and 36 months, while MAT-treated patients showed stable improvements. This temporal pattern suggests that the fibrotic response to RFA may undergo late remodeling or relaxation, while the mechanical resection achieved with MAT produces more permanent volumetric reduction.

Strengths

This study has several methodological strengths that enhance the validity and clinical utility of its findings.

First, we employed a comprehensive search strategy across three major databases (PubMed, Scopus, and Web of Science) following the PRISMA 2020 guidelines, ensuring the maximal capture of relevant RCTs. Second, the exclusive inclusion of randomized controlled trials minimizes confounding and selection bias, providing the highest level of evidence for comparative effectiveness. Third, we conducted meta-analyses for both subjective (patient-reported VAS) and objective (acoustic rhinometry) outcomes, allowing triangulation of findings across different measurement domains. Fourth, the risk of bias assessment using the Cochrane RoB 2 tool proven predominantly low bias across included studies, with four of seven trials achieving low-risk ratings in all domains. Finally, by including studies with follow-up extending to three years, this review addresses a critical gap in the literature on long-term durability, a key consideration for clinical decision-making.

Limitations

Several limitations call for consideration when interpreting our findings. First, the number of included studies ($n = 7$) and their sample sizes (ranging from 40 to 106 patients) are modest, potentially limiting statistical power for detecting small but clinically meaningful differences. Second, variability in surgical protocols, including differences in RFA devices (Sutter generator, Ellman Surgitron, Gyrus ENT), energy settings (8-17 W), treatment durations, and MAT techniques (microdebrider speed 3000-5000 rpm, blade types), may introduce uncontrolled confounding and limit generalizability. Third, the inherent difficulty of blinding surgeons and patients in surgical trials introduces potential performance and detection bias, reflected in the "some concerns" ratings for three studies due to deviations from intended interventions and outcome measurement issues. Fourth, long-term evidence beyond 12 months is primarily derived from a single multicenter study [15] and one added trial [20], highlighting the need for confirmation in larger cohorts. Fifth, we could not assess publication bias quantitatively due to the small number of studies, although our comprehensive search strategy minimizes this risk. Sixth, the absence of standardized outcome measures across studies, particularly for quality of life, precluded meta-analysis of this important patient-centered domain. Finally, the exclusion of non-English language publications may introduce language bias, although the impact is minimal given the international representation of included studies (Finland, Italy, France, Türkiye).

Clinical and research implications

Our findings support both RFA and MAT as effective minimally invasive options for patients with medically refractory inferior turbinate hypertrophy. The choice between techniques should be individualized through shared decision-making that considers patient priorities, risk tolerance, and surgeon expertise. For patients seeking rapid recovery and willing to accept a modest risk of intraoperative bleeding, MAT offers superior long-term durability and lower recurrence rates, advantages that may justify its slightly more invasive nature. Conversely, for patients at increased bleeding risk or those prioritizing avoidance of intraoperative complications, RFA is still a viable option with comparable short-term efficacy, provided they are counseled about the higher likelihood of prolonged postoperative crusting and potential need for revision surgery. Surgeons should also consider that MAT requires specialized equipment and familiarity with microdebrider techniques, which may influence procedure selection based on institutional resources and individual ability.

Future directions

Future research should prioritize large-scale, multicenter RCTs with standardized surgical protocols and extended follow-up periods exceeding three years. Standardizing objective assessment tools is also recommended to enable more precise comparisons between various turbinoplasty modalities.

Conclusion

In conclusion, both RFA and MAT are effective surgical interventions for improving nasal obstruction and airflow in patients with turbinate hypertrophy. However, MAT shows a superior long-term efficacy, offering more durable symptomatic relief and a significantly lower recurrence rate compared to RFA. While RFA is still a viable minimally invasive way, MAT is the recommended technique for patients prioritizing long-term stability based on current evidence. The choice of procedure should be guided by a shared decision-making process, balancing MAT's superior durability against its potential intraoperative risks, such as bleeding.

Conflicts of Interest

The authors declare that they have no conflict of interest regarding the publication of this article.

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Supplementary content (If any) is available online.

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