Outcomes of microdebrider-assisted versus radiofrequency-assisted inferior turbinate reduction surgery: a systematic review and meta-analysis of interventional randomised studies*

Ahmad A. Mirza[1], Talal A. Alandejani[2], Hatim Y. Shawli[3], Mohammed S. Alsamel[4], Mohammad O. Albakrei[5], Hebatullah M. Abdulazeem[6]

Rhinology 58: 6, 530 - 537, 2020
https://doi.org/10.4193/Rhin19.350

[1] Department of Otolaryngology, Head and Neck Surgery, Faculty of Medicine in Rabigh, King Abdulaziz University, Jeddah, Saudi Arabia, and Department of Otolaryngology, Head and Neck Surgery, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia
[2] Department of Surgery-Division of Otolaryngology, King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia, and Department of Surgery-Division of Otolaryngology, Ministry of the National Guard – Health Affairs, Jeddah, Saudi Arabia, and King Abdullah International Medical Research Center, Jeddah, Saudi Arabia
[3] Department of Otolaryngology, Head and Neck Surgery, Faculty of Medicine, University of Jeddah, Jeddah, Saudi Arabia
[4] Department of Otolaryngology, Head and Neck Surgery, King Fahad General Hospital, Jeddah, Saudi Arabia
[5] Department of Otolaryngology, Head and Neck Surgery, King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia
[6] Department of Sport and Health Sciences, Technische Universität München, München, Germany

***Received for publication:**
October 18, 2019
Accepted: May 7, 2020

Abstract

Background: The microdebrider technique was introduced in clinical practice to provide a better outcome in nasal obstruction caused by inferior turbinate hypertrophy. We conducted this systematic review to evaluate the effectiveness of this technique, by comparison with the radiofrequency-assisted modality.

Methodology: PubMed, Embase and the Cochrane Central Register of Controlled Trials (CENTRAL) databases were searched to retrieve relevant randomised studies published prior to November 2019. Randomised Trials in English that studied the difference between the two techniques among adult patients were eligible for the current review. Data extraction and study inclusion were guided by PRISMA guidelines. The outcome measures were visual analogue scale (VAS, 0-10) for nasal obstruction, anterior active rhinomanometry, and acoustic rhinometry. A meta-analysis was carried out to quantify the difference between the two techniques, for each measured outcome.

Results: Seven randomised trials were included and quantitatively analysed in this meta-analysis. Our analysis revealed that the microdebrider-assisted technique demonstrated significantly better VAS (0-10) for nasal obstruction scores in early and late postoperative follow-up. Whilst no difference was noted using the objective measurements (rhinomanometry and acoustic rhinometry) at early follow-up, microdebrider-assisted technique showed superior results in long-term follow-up, as evidenced using anterior active rhinomanometry.

Conclusions: The microdebrider-assisted technique results in a better outcome, particularly in long-term follow-up, when compared with radiofrequency.

Key words: nasal obstruction, turbinate, radiofrequency therapy, randomised controlled trial, review, rhinology, visual analogue scale, surgery, systematic review, meta-analysis

Introduction

Chronic nasal airway obstruction is an unpleasant symptom that is commonly encountered among patients attending otolaryngology clinics worldwide. Of the many causes that have been reported, nasal turbinate hypertrophy is one that has a major impact on patients' quality of life[1]. Nasal turbinate is an important structure in regulating nasal airflow and protecting against external pathogens.

Causes of enlarged turbinate can be classified into allergic versus non-allergic[1]. The conservative approach is by far the main method of treatment[2]. If medical therapy fails to alleviate the symptoms, the surgical option can be considered. A variety of surgical techniques have evolved over the years and have been adopted by many surgeons[3,4]. However, there is still a lack of consensus on the optimal method of surgery[5]. Besides symptomatic relief, successful surgery is one that maintains the respiratory mucosa in an intact configuration and preserves its functions[6]. Given that turbinate surgeries potentially lead to complications, due to inevitable destruction of the mucosa, the optimal goal is rarely attained.

Therefore, in recent years, researchers have continued to study minimally invasive techniques that cause fewer side effects. Microdebrider-assisted inferior turbinoplasty (MAIT) and radiofrequency-assisted inferior turbinoplasty (RAIT) are widely used methods that showed advantages over other techniques in terms of mucosal preservation and postoperative side effects[7,8]. A recent systematic review evaluated the efficacy of the two techniques and showed that both had favourable outcomes[9]. However, the study was limited by lack of long-term follow-up and the small number of randomised trials. Therefore, our aim was to contrast the two techniques for short- and long-term changes in both subjective and objective measures through resutls obtained from randomised interventional studies.

Methods

Protocol and registration

Before the authors commenced the present study, the PROSPERO International Prospective Register of Systematic Review was approached to register the study (No. CRD42019130517). This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[10].

Data sources and searches

Different electronic databases were reviewed for published English studies from the inception until October 2019. These included PubMed, Embase and Cochrane Central Register of Controlled Trials (CENTRAL). The initial search strategy involved using relevant search words, including ("turbinoplasty" OR "turbinate reduction") AND "microdebrider" AND "radiofrequency". In addition, we employed controlled vocabularies (MeSH terms and Emtree). The detailed search strategy is described in the supplement (Appendix 1). References in the included articles were also searched for potentially relevant trials. No restrictions were applied on study period or sample size.

Study selection and outcome definition

Only studies that met the following two criteria were included in current review: 1) randomised interventional studies conducted on adult individuals diagnosed with inferior turbinate hypertrophy unresponsive to a trial of medical regimens; 2) compared the difference in outcomes before and after the surgery for microdebrider versus radiofrequency. Trials that evaluated the treatment outcome with a single arm treatment were excluded. In addition, studies reporting other concomitant conditions causing nasal obstruction (e.g. symptomatic deviated nasal septum, nasal polyps, sinusitis, concha bullosa, collapse of alar cartilage or tumours of the nose or paranasal sinuses) were excluded. Cadaveric experiments, observational studies such as case reports and case series, reviews, conference papers, and commentaries, were also excluded from this review. Two authors (A.M. and M.S.A.) independently reviewed the selected studies and assessed both titles and abstracts to detect potentially relevant studies. The full texts of the relevant studies were assessed for eligibility. In case of a conflict, agreement was reached through a discussion between the authors. The primary outcome was symptom relief by visual analogue scale (VAS, 0-10) for nasal obstruction. Secondary outcomes were anterior active rhinomanometry results, acoustic rhinometry results and side effects of the procedures.

Data extraction and quality assessment

The eligible studies were reviewed, and a data extraction form was used to extract the data. The standardised data extraction form contained the authors' names, year of publication, study design, country, number of subjects in each group, participant characteristics, diagnostic criteria of the condition, surgical technique and the outcomes. Each primary study was evaluated by two authors (AM and HA) for risk of bias using Cochrane Collaboration's tool for assessing risk of bias for randomised controlled trials[11]. The tool assesses seven domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other biases. Overall, the studies were graded and classified as "low risk", "unclear risk", and "high risk".

Data synthesis and statistical analysis

A meta-analysis was performed to compare baseline to post-intervention change scores for nasal obstruction between the microdebrider and radiofrequency method. The analysis was carried out using Comprehensive Meta-Analysis Package, Ver-

Table 1. Characteristics of the included studies.

Authors	Year	Country	Study design	N	Diagnosis of ITH	RAIT technique	Gender (M/F)	Age (years) (Mean ±SD)
Akagün et al.[21]	2016	Turkey	Prospective, interventional, randomised, and single-blinded	40	Decrease in TNR and improvement in nasal patency after decongestion.	Gyrus ENT Somnoplasty; Model 735000, Tokyo, Japan	21/19	MAIT: 31.20 ±11.31; RAIT: 33.10 ±14.20
Pelen et al.[16]	2016	Turkey	Prospective interventional randomised	40	NR	Ellman Surgitron FFPF EMC (Elman International Inc., Hewlett, NY, USA) generator	20/20	38.65 ±13.56
Vijay Kumar et al.[14]	2013	India	Prospective interventional randomised	60	Diagnosis made by exclusion of other causes of nasal obstruction.	Ellman, Surgitron FFPF EMC, Ellman International Inc. NY, USA	NR	Mean: 27.86; range: 14-45
Harju et al.[22]	2018	Finland	Prospective, interventional, randomised placebo controlled, and single-blinded	98	Symptom relief, swelling shrinkage and at least 30% improvement in acoustic rhinometry after nasal decongestant.	Sutter RF generator BM-780 II; Sutter, Freiburg, Germany	56/42	Median: 46; range: 19-69
Lee et al.[17]	2006	South Korea	Prospective interventional randomised	60	Decongestion test using a Bosmin cotton pledget, and Improvement in acoustic rhinometry after nasal decongestant.	Somnus Medical Technology, Inc., Sunnyvale, CA, USA	37/23	MAIT: 29.4; RAIT: 28.3
Liu et al.[19]	2009	Taiwan	Prospective interventional randomised	120	At least 35% decrease in unilateral nasal resistance on rhinomanometry.	ENTec Coblator Plasma Surgery System (Arthrocare Corp., Sunnyvale, Calif., USA)	63/57	Mean: 37.5; range: 18-59
Hegazy et al.[18]	2014	Saudi Arabia	Prospective interventional randomised	70	Diagnosis was not described properly. Without use of nasal decongestant, ITH was graded by Friedman grading system. Patient with grade 2 or 3 were included.	coblator® II system (ENTec, a division of Arthrocare®, Sunnyvale, CA, USA)	34/36	MAIT: 24 ±3; RAIT: 23 ±4
Essam Fathy et al.[20]	2016	Egypt	Prospective interventional randomised	60	Diagnosis made by exclusion of other causes of nasal obstruction.	ENTec Coblator Plasma Surgery System® (Arthrocare Corp®)	NR	Mean: 27.86
Kizilkaya et al.[15]	2008	Turkey	Prospective, interventional, randomised, and single-blinded	30	Swelling shrinkage after nasal decongestant	Somnus S2 radiofrequency generator (Somnus Medical Technologies, Inc, Sunnyvale, CA, USA)	NR	29.4 ±6.7

ITH: Inferior turbinate hypertrophy; MAIT: Microdebrider-assisted inferior turbinoplasty; RAIT: Radiofrequency-assisted inferior turbinoplasty; TNR: Total nasal resistance; NR: Not reported.

sion 3.3.070, 2014 (Biostat, Englewood, NJ, USA). The reported baseline and post-treatment values were extracted, and data were entered in mean and standard deviation format. Where median and interquartile ranges were reported, mean and standard deviation were estimated as per special formulas[12,13]. The baseline to post-intervention change scores of VAS (0-10) for nasal obstruction were estimated at three distinct times, three to six months, one year, and two years after the surgery. The VAS (0-10) for nasal obstruction ranges from 1 (indicating least severe) to 10 (indicating most severe). Results of nasal obstruction relief estimated by anterior active rhinomanometry and acoustic rhinometry were pooled in further analyses. A comparison between the two techniques by using the baseline to post-treatment change scores of anterior active rhinomanometry was made at one-to-six months and two years after the intervention. The acoustic rhinometry results were tested at two-to-three months after the intervention. Both interventions had a negative effect direction on VAS (0-10) for nasal obstruc-

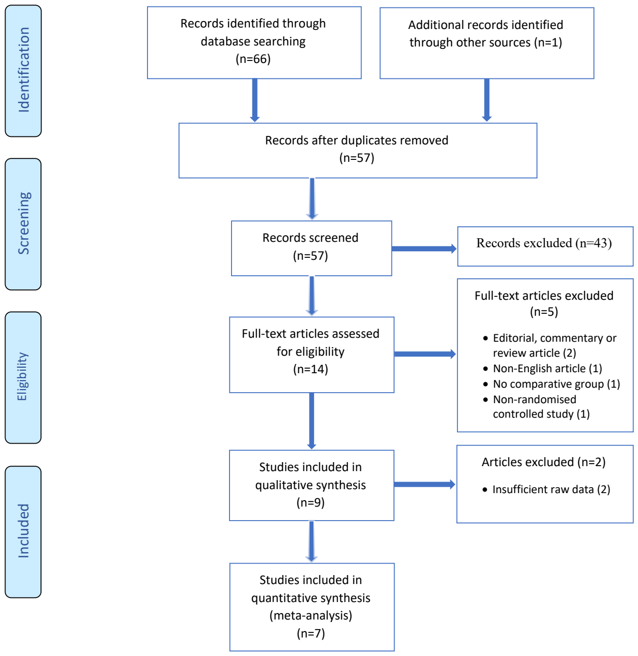

Figure 1. Flow chart depicting the method of study selection.

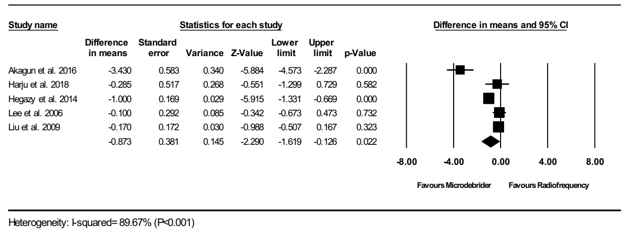

Figure 2. Forest plot depicting the mean change in visual analogue scale (VAS) for nasal obstruction at 3-6 months follow-up.

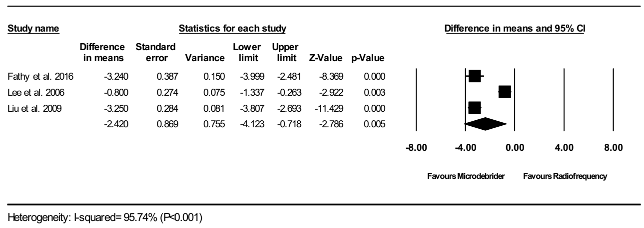

Figure 3. Forest plot depicting the mean change in visual analogue scale (VAS) for nasal obstruction at 1 year follow-up.

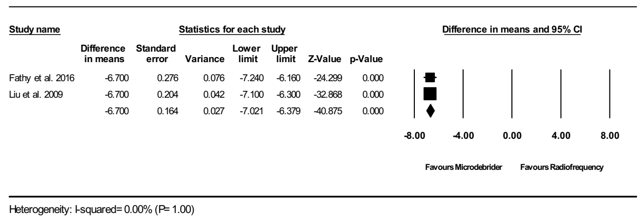

Figure 4. Forest plot depicting the mean change in visual analogue scale (VAS) for nasal obstruction at 2 years follow-up.

tion and anterior active rhinomanometry, whilst they had a positive effect direction on acoustic rhinometry. A random-effects model was used to pool the effect sizes, and a forest plot was generated to demonstrate these effect sizes. Statistical heterogeneity across the included studies was measured using I^2 statistics. The values range from 0 % (complete consistency) to 100 % (complete inconsistency). Statistical significance was determined by a P value of <0.05.

Results

Data sources

Of 67 studies identified, 10 were duplicates and were removed. A total of 57 studies was screened for eligibility. Excluding some articles due to irrelevancy yielded 14 potentially relevant studies. Eventually, a total of 9 articles were included in the current review (Table 1). A subset of 2 studies were excluded from the quantitative synthesis due to lack of raw data[14,15]. The flow diagram of the study selection is presented in Figure 1.

Subjective outcome

Table 2 shows the baseline values of VAS (0-10) for nasal obstruction. Compared with radiofrequency, the microdebrider method showed a relatively greater improvement in VAS (0-10) for nasal obstruction at early and late postoperative follow-ups. For early follow-up (at three to six months after the surgery), the difference of reduction in VAS (0-10) for nasal obstruction score favoured the microdebrider technique (MD -0.873, 95% CI: -1.619, -0.126; P= 0.022; Figure 2). Likewise, the microdebrider group witnessed a higher reduction in VAS (0-10) for nasal obstruction score at one year postoperatively (MD -2.420, 95% CI: -4.123, -0.718; P= 0.005; Figure 3); and at two years after the surgery (MD -6.700, 95% CI: -7.021, -6.379; P<0.001; Figure 4).

Objective outcome

The baseline scores of both objective outcomes are presented in Table 2. Anterior active rhinomanometry results showed that the improvement measured in the early months after the microdebrider procedure was not significantly higher than the compared technique (MD -0.014, 95% CI: -0.034, 0.006; P=0.167; Figure 5). The difference was of statistical significance at two years follow-up, in favor of the microdebrider procedure (MD -0.146, 95% CI: -0.164, -0.127; P<0.001; Figure 6). However, the acoustic rhinometry demonstrated no difference between the two techniques in the short-term follow up (MD 0.291, 95% CI: -0.425, 1.007; P=0.425; Figure 7).

Adverse events and complications rate

In general, both procedures were well tolerated by the patients.

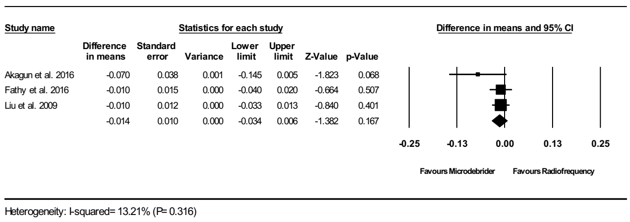

Figure 5. Forest plot depicting the mean change in anterior active rhinomanometry at 1-6 months follow-up.

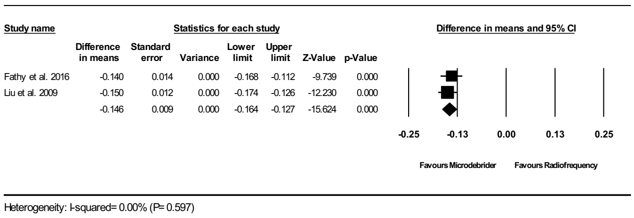

Figure 6. Forest plot depicting the mean change in anterior active rhinomanometry at 2 years follow-up.

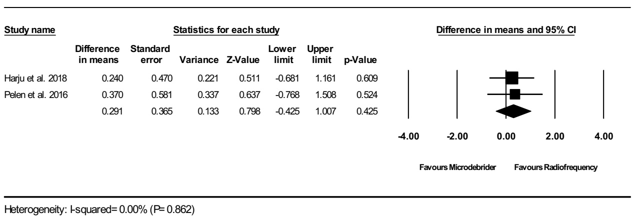

Figure 7. Forest plot depicting the mean change in acoustic rhinometry (volume) at 2-3 months follow-up.

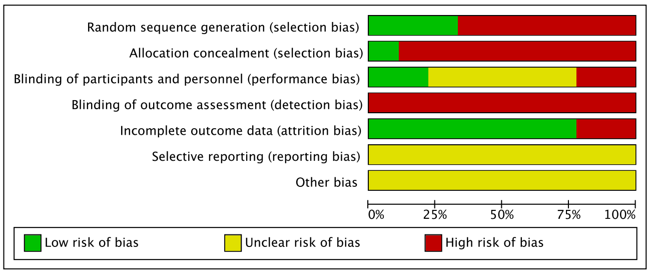

Figure 8. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

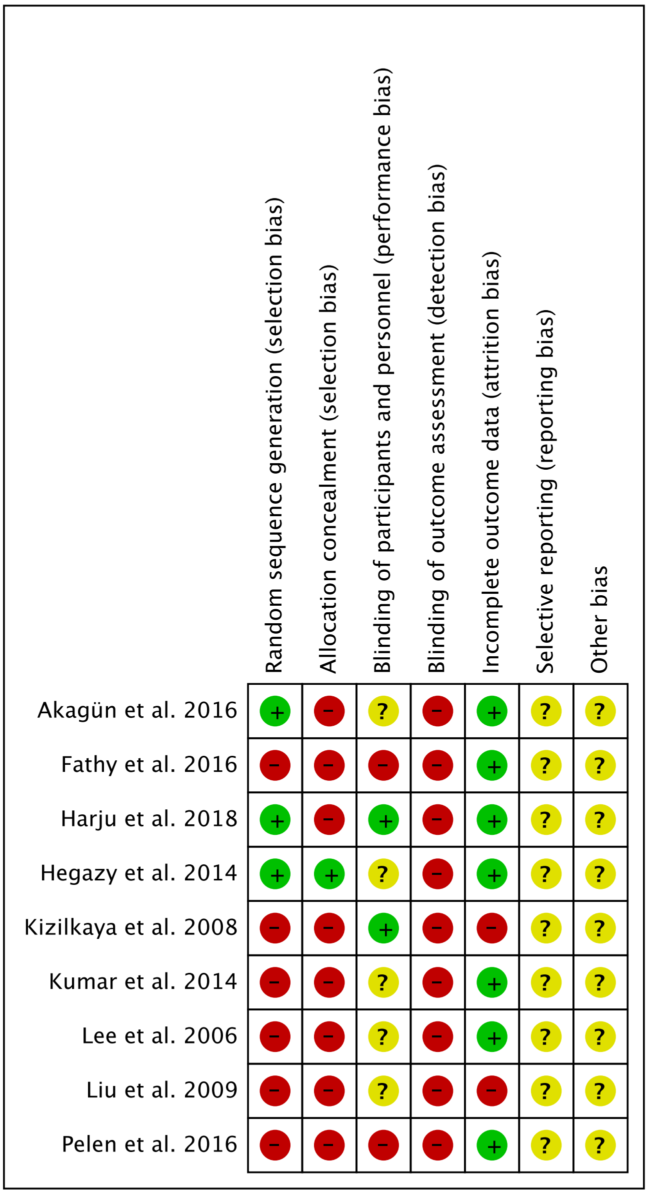

Figure 9. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

However, a small number of complications were reported. Bleeding was commonly reported in the microdebrider group. Pelen et al. examined 20 patients for each group and recorded 4 cases of bleeding among patients who underwent microdebrider procedure, compared to none in the radiofrequency group[16]. Similarly, Lee et al. reported 26% rate of bleeding in microdebrider group compared with their counterparts (6.6%)[17]. Nevertheless, Hegazy et al. found no statistically significant difference between the two groups in terms of postoperative bleeding[18]. Notably, in most cases, bleeding was minor and stopped with standard anterior packing. Other reported adverse events were crusting, mucosal tears and synechia, which occurred more commonly in the microdebrider groups[15, 19, 20]; however, some authors did not observe significant difference between the two techniques[14, 16,18]. Overall, the complication rate was more common in the microdebrider group than in radiofrequency[16].

Heterogeneity assessment

The included studies showed complete consistency in the results of the long-term follow-up using the VAS (0-10) for nasal obstruction and the anterior active rhinomanometry ($I^2 = 0.00$). In addition, no heterogeneity was found in the short-term

Table 2. Baseline values of the measured outcomes.

Authors	Baseline VAS (0-10) score for nasal obstruction (Mean ± SD)	Anterior active rhinomanometry, baseline TNR (Mean ± SD)	Acoustic rhinometry, baseline volume (Mean ± SD)
Fatih Akagün et al.[21]	RAIT: 5.99 ±1.60 MAIT: 6.69 ±1.67 P-value = 0.191 (NS)	RAIT: 0.28 ±0.07 MAIT: 0.34 ±0.18 P-value = 0.213 (NS)	NR
Arda Pelen et al.[16]	NR	NR	RAIT: 3.90 ±1.54 MAIT: 3.70 ±1.32 P-value = 0.536 (NS)
K. Vijay Kumar et al.[14]	NR	NR	NR
Teemu Harju et al.[22]	Median (IQR) RAIT: 8.0 (6.3-8.9) MAIT: 8.0 (7.0-9.0) P-value (NS)	NR	Median (IQR) RAIT: 4.39 (3.02-5.65) MAIT: 3.57 (2.52-4.58) P-value (NS)
Jae Yong Lee et al.[17]	RAIT: 7.20 ±1.27 MAIT: 7.10 ±1.16 P-value > 0.05 (NS)	NR	NR
Chia-Min Liu et al.[19]	RAIT: 8.53 ±1.03 MAIT: 8.68 ±1.05 P-value (NR)	RAIT: 0.31 ±0.06 MAIT: 0.32 ±0.08 P-value >0.05 (NS)	NR
Hassan M. Hegazy et al.[18]	RAIT: 7 ±0.7 MAIT: 8 ±0.7 P-value (NR)	NR	NR
Essam Fathy et al.[20]	RAIT: 8.52 ±1.02 MAIT: 8.67 ±1.04 P-value (NR)	RAIT: 0.30 ±0.05 MAIT: 0.31 ±0.07 P-value >0.05 (NS)	NR
Zeynap kizilkaya et al.[15]	NR	NR	NR

MAIT: Microdebrider-assisted inferior turbinoplasty; RAIT: Radiofrequency assisted inferior turbinoplasty; VAS: Visual analogue scale; TNR: Total nasal resistance; IQR: Interquartile range; NR: Not reported; NS: Not significant.

follow-up when using acoustic rhinometry.

Quality assessment

The risk of bias was thoroughly assessed using the Cochrane assessment tool and depicted in Figures 8 and 9. With exception of three studies[18, 21, 22], the included studies failed on disclosing the random sequence generation method, and thereby the risk of bias in the domain of randomization was high in the majority of studies. Except for a single high quality study[18], the eligible trials were at high risk of allocation concealment bias. Hegazy et al.[18] carried out this high-quality study, in which they generated an adequate random sequence method and described a proper allocation concealment, with brown envelopes containing a folded card being used. Concerning performance bias, two studies were reported as single-blinded[15, 22]. None of the included studies explicated the blinding status of outcome assessors. Thus, all included studies were deemed to have a high risk of detection bias. In regard to attrition bias, two studies[15, 19] did not provide a reason for the loss of follow-up among their participants. Therefore, we considered that these outcome data were reported inadequately, and thus these studies were at a high risk of bias in this domain. Given that all 9 studies failed to refer to a study protocol and there was insufficient information to permit judgment, the selective reporting domain causes concern about the risk of bias in the included trials.

Discussion

The current study was undertaken to evaluate the difference between MAIT and RAIT in terms of short- and long-term subjective and objective outcomes. Our findings suggested that the microdebrider approach was more favourable for patients who underwent inferior turbinoplasty. In particular, MAIT showed a significant superiority in VAS (0-10) for nasal obstruction measure, both in the short- and the long-term. These results further improved and were maintained for the following 2 years after the surgery. As per the objective clinical assessment, early improvement did not differ between the two techniques; however, when the late findings (the two-year results) of anterior active rhinomanometry were evaluated for the two techniques, a significant difference in nasal resistance was noted in favour of MAIT. Notably, there was insufficient data to evaluate the long-term results of acoustic rhinometry.

A previous published meta-analysis evaluating the improvement following the two techniques concluded that both techniques produced a significant subjective and objective improvement in nasal airflow[9]. It might be worth noting that the previous review was limited by the types of studies included in the review, with observational-based findings. Thus, a high level of heterogeneity was noted. Another limitation is the short-term follow-up, with median length of 6 months.

The mechanism of action and consequent effect of each technique explain the short- and long-term outcome results and the relative merits between the two techniques. Given the time required for fibroblasts to replace the area surrounding the resultant submucosal necrosis of radiofrequency surgery, the desired effects may be significant only after a long period of time[23]. For the short- and long-term outcome, the superiority of the microdebrider method can be better explained by a number of theories. In addition to the added feature of partial turbinectomy, the microdebrider method has a capability of providing real-time suction[24]. Secondly, the resultant tissue fibrosis of the radiofrequency technique may be insufficient to cause shrinkage of the turbinate structure, especially in patients with prolonged mucosal hypertrophy[17].

Objective tests after turbinoplasty are as important as subjective feedback from the patients. Further, the decrease in nasal resistance after turbinoplasty has been linked to improvement in quality of life[25]. Although objective measures, including rhinomanometry and acoustic rhinometry, showed no difference at six-months follow-up, later follow-up assessments demonstrated a significant difference between the two techniques. It should be noted that slight mucosal swelling, which is reported at a later period with radiofrequency, may increase the nasal resistance[17]. Literature indicated that the acoustic rhinometry test responds better than rhinomanometry[26]; however, there is no long-term data available from the primary studies to conclude for the long-term results of acoustic rhinometry.

Quality of evidence: According to the designed protocol, we conducted a thorough literature search and processed the study selection and data extraction in duplicate. The assessment of the risk of bias using the Cochrane tool revealed that the included studies were of unclear risk of bias for selective reporting, due to a lack of predefined outcomes. Further, the major source of bias was detection bias, where outcome assessors were likely to be not blinded. Selection bias was rated from unclear (in the majority of studies) to low risk. Performance bias, on the other hand, was judged to be low to high risk.
Clinical implication: The results of our review are in favour of MAIT as a better-outcome surgical procedure in comparison with RAIT in the management of nasal obstruction caused by enlarged inferior turbinate. Clinically, nasal obstruction is further improved with better scores in the late follow-up indicating that microdebrider potentially provides the best long-term outcome with sustainable results. Given that the sustained difference in long-term follow up is of more than 1 (on VAS scale of 0-10), this technique is clinically relevant[27]. It is also noteworthy that microdebrider stimulates the regeneration of epithelium and does not damage the respiratory epithelium[28]. Consistently, a study showed that the radiofrequency does not offer the advantage of the improvement in mucociliary clearance[29]. It is also important to evaluate the cost effectiveness while comparing these two techniques. MAIT has more favourable cost-effectiveness than RAIT[23]. Thus, adoption of this technique could be recommendable. However, there may be resistance in using this type of turbinoplasty in real practice, due to the side effects and lack of experience.

The correlation between the subjective complaint of nasal obstruction and objective measure of nasal resistance is controversial[30, 31]. However, the VAS (0-10) for nasal obstruction appears clinically important as it is able to quantify this symptom with a good reliability, in the absence of rhinomanometry[32]. Hence, patient perception of relief, after turbinoplasty, can potentially serves as a useful and reliable clinical indicator of outcome of surgery, by which a comparison between the two modalities of treatment can be made. In our study, nevertheless, both subjective and objective measurements were considered and analysed.

The limitations of the current study included the relatively small number of studies and the questionable quality of some of these trials. Moreover, adults from different countries were examined by a large number of clinicians with various types of RAIT devices and settings used, hence the results should be interpreted cautiously.

Conclusion

In summary, MAIT showed promising and potentially sustainable effects over RAIT, based on results of patient experience and objective assessments. However, the complication rate was relatively higher in MAIT.

Acknowledgements

Ahmad A. Mirza is eternally grateful to Harvard T. H. Chan School of Public Health for their series of lectures in meta-analysis delivered during his master degree journey. He extends his thanks to the Department of Community Medicine at King Abdulaziz University, Jeddah, Saudi Arabia for their role in enhancing our skills and knowledge in the field of epidemiology and biostatistics. Ahmad Mirza also would like to acknowledge the endless support and encouragement received from his parents and maternal aunts and for their sacrifice. Finally, the authors would like to thank Dr. Mohamed Haireche for English language editing.
No funding was received for the study.

Authorship contribution

Study concept: AM, TA, HS; Search strategy: AM, MSA, MOA, HA; Screening of retrieved studies: AM, MSA; Metanalysis: AM, TA; Quality assessment: AM, HA; Writing: AM, TA, HS, MSA, MOA, HA; Revision: AM, TA, HS, MSA, MOA, HA

Conflict of interest

None.

References

1. Willatt D. The evidence for reducing inferior turbinates. Rhinology, 2009. 47(3): 227-736.
2. Hoover S. The nasal patho-physiology of headaches and migraines. Diagnosis and treatment of the allergy, infection and nasal septal spurs that cause them. Rhinology, 1987. 2: 1-23.
3. Hol MKS, Huizing EH. Treatment of inferior turbinate pathology: A review and critical evaluation of the different techniques. Rhinology, 2000. 38(4): 157-166.
4. Mabry RL. Inferior turbinoplasty: Patient selection, technique, and long-term consequences. Otolaryngol Head Neck Surg, 1988. 98(1): 60-66.
5. Batra PS, Seiden AM, Smith TL. Surgical management of adult inferior turbinate hypertrophy: A systematic review of the evidence. Laryngoscope, 2009. 119(9): 1819-1827.
6. Bhandarkar ND, Smith TL. Outcomes of surgery for inferior turbinate hypertrophy. Curr Opin Otolaryngol Head Neck Surg, 2010. 18(1): 49-53.
7. Martinez SA, Nissen AJ, Stock CR, Tesmer T. Nasal turbinate resection for relief of nasal obstruction. Laryngoscope, 1983. 93(7): 871-875.
8. Fanous N. Anterior turbinectomy. A new surgical approach to turbinate hypertrophy: a review of 220 cases. Arch Otolaryngol Head Neck Surg, 1986. 112(8): 850-852.
9. Acevedo JL, Camacho M, Brietzke SE. Radiofrequency ablation turbinoplasty versus microdebrider-assisted turbinoplasty: a systematic review and meta-analysis. Otolaryngol Head Neck Surg, 2015. 153(6): 951-956.
10. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Int J Surg, 2010. 8(5): 336-341.
11. Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ, 2011. 343: d5928.
12. Luo D, Wan X, Liu J, Tong T. Optimally estimating the sample mean from the sample size, median, mid-range, and/or mid-quartile range. Stat Methods Med Res, 2018. 27(6): 1785-1805.
13. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol, 2014. 14: 135.
14. Vijay Kumar K, Kumar S, Garg S. A Comparative Study of Radiofrequency Assisted Versus Microdebrider Assisted Turbinoplasty in Cases of Inferior Turbinate Hypertrophy. Indian J Otolaryngol Head Neck Surg, 2014. 66(1): 35-39.
15. Kizilkaya Z, Ceylan K, Emir H, et al. Comparison of radiofrequency tissue volume reduction and submucosal resection with microdebrider in inferior turbinate hypertrophy. Otolaryngol Head Neck Surg, 2008. 138(2): 176-181.
16. Pelen A. Comparison of the effects of radiofrequency ablation and microdebrider reduction on nasal physiology in lower turbinate surgery. Turkish J Ear Nose Throat, 2017. 26(6): 325-332.
17. Lee JY, Lee JD. Comparative study on the long-term effectiveness between coblation- and microdebrider-assisted partial turbinoplasty. Laryngoscope, 2006. 116(5): 729-734.
18. Hegazy HM, ElBadawey MR, Behery A. Inferior turbinate reduction; coblation versus microdebrider - A prospective, randomised study. Rhinology, 2014. 52(4): 306-314.
19. Liu CM, Tan CD, Lee FP, Lin KN, Huang HM. Microdebrider-assisted versus radiofrequency-assisted inferior turbinoplasty. Laryngoscope, 2009. 119(2): 414-418.
20. Fathy E. Comparative Study of Micro debrider-Assisted Versus Radio frequency-Assisted Inferior Turbinoplasty. Med J Cairo Univ, 2016. 84(2): 339-345.
21. Akagun F, Imamoglu M, Cobanoglu HB, Ural A. Comparison of radiofrequency thermal ablation and microdebrider-assisted turbinoplasty in inferior turbinate hypertrophy: a prospective, randomized, and clinical study. Turkish Arch Otolaryngol, 2016. 54(3): 118-123.
22. Harju T, Numminen J, Kivekäs I, Rautiainen M. A prospective, randomized, placebo-controlled study of inferior turbinate surgery. Laryngoscope, 2018. 128(9): 1997-2003.
23. Cingi C, Ure B, Cakli H, Ozudogru E. Microdebrider-assisted versus radiofrequency-assisted inferior turbinoplasty: a prospective study with objective and subjective outcome measures. Acta Otorhinolaryngol Ital, 2010. 30(3): 138-143.
24. Gupta A, Mercurio E, Bielamowicz S. Endoscopic inferior turbinate reduction: an outcomes analysis. Laryngoscope, 2001. 111(11 Pt 1): 1957-1959.
25. Huang TW, Cheng PW. Changes in nasal resistance and quality of life after endoscopic microdebrider-assisted inferior turbinoplasty in patients with perennial allergic rhinitis. Arch Otolaryngol Head Neck Surg, 2006. 132(9): 990-993.
26. Ansari E, Rogister F, Lefebvre P, Tombu S, Poirrier A-L. Responsiveness of acoustic rhinometry to septorhinoplasty by comparison with rhinomanometry and subjective instruments. Clin Otolaryngol, 2019. 44(5): 778-783.
27. Bousquet PJ, Combescure C, Klossek JM, Daurès JP, Bousquet J. Change in visual analog scale score in a pragmatic randomized cluster trial of allergic rhinitis. J Allergy Clin Immunol, 2009. 123(6): 1349–1354.
28. Neri G, Mastronardi V, Traini T, D'Orazio F, Pugliese M, Cazzato F. Respecting nasal mucosa during turbinate surgery: end of the dogma? Rhinology, 2013. 51(4): 368-375.
29. Romano A, Dell'Aversana Orabona G, Salzano G, Abbate V, Iaconetta G, Califano L. Comparative study between partial inferior turbinectomy and microdebrider-assisted inferior turbinoplasty. J Craniofac Surg, 2015. 26(3): e235-e238.
30. Mori S, Fujieda S, Yamada T, Kimura Y, Takahashi N, Saito H. Long-term effect of submucous turbinectomy in patients with perennial allergic rhinitis. Laryngoscope, 2002. 112(5): 865–869.
31. McCaffrey TV, Kern EB. Clinical evaluation of nasal obstruction. A study of 1,000 patients. Arch Otolaryngol, 1979. 105(9): 542–545.
32. Ciprandi G, Mora F, Cassano M, Gallina AM, Mora R. Visual analog scale (VAS) and nasal obstruction in persistent allergic rhinitis. Otolaryngol Head Neck Surg, 2009. 141(4): 527–529.

Ahmad A. Mirza, MBBS MSc
Department of Otolaryngology
Head and Neck Surgery
Faculty of Medicine in Rabigh
King Abdulaziz University
Jeddah
Saudi Arabia
P.O. Box 80205
Jeddah 21589
Saudi Arabia

E-mail: aamirza1@kau.edu.sa
ORCID: https://orcid.org/0000-0001-6035-9566

SUPPLEMENTARY INFORMATION

APPENDIX 1

Embase search (October 2019).

#	Searches	Results
1	'turbinate'/exp OR turbinate	7021
2	'radiofrequency'/exp OR radiofrequency	72914
3	'microdebrider'/exp OR microdebrider	535
4	#1 and #2 and #3	33

Cochrane Central Register for Controlled Trials search (October 2019).

#	Searches	Results
1	exp turbinates	19
2	(turbinate):ti,ab,kw	562
3	(radiofrequency):ti,ab,kw	4109
4	(microdebrider):ti,ab,kw	98
5	1 or 2	578
6	3 or 4 or 5	14

PubMed search (October 2019).

#	Searches	Results
1	Turbinates[MeSH Terms]	3171
2	Radiofrequency Therapy[MeSH Terms]	32174
3	Microdebrider	346
4	Turbinoplasty	223
5	Radiofrequency	32879
6	1 or 4	3264
7	2 or 5	48940
8	3 and 6 and 7	19