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What is This?
Snoring Management with Nasal Surgery and Upper Airway Radiofrequency Ablation

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Abstract

Objective. To review techniques and outcomes of nasal surgery with upper airway radiofrequency ablation (RFA) when used for socially disruptive snoring, including the rate of infection with reused RFA applicator tips.

Study Design. Case series with chart review.

Setting. Community-based sleep-disordered breathing clinic.

Methods. A prospectively acquired sleep quality assurance database was reviewed to determine demographics, complications, snoring outcomes, level of daytime sleepiness, and sleep-related quality of life in patients with socially disruptive snoring treated with nasal surgery and upper airway RFA.

Results. One hundred thirty patients (48 women; 82 men) with a mean age of 50 years (range, 24-83 years) underwent nasal surgery and upper airway RFA for the treatment of chronic nasal blockage with socially disruptive snoring. All patients underwent septoplasty with or without inferior turbinate reduction and RFA to the soft palate and/or base of tongue. Patients received a mean of 2.2 (range, 1-4) applications of upper airway RFA during the course of treatment. No infections occurred with reuse of applicator tips. Fifty-four bed partners (42%) reported complete snoring resolution, whereas 68 (52%) reported residual snoring that was improved. Snoring resolution was more common in patients who underwent repeated applications of upper airway RFA (odds ratio 2.39; 95% confidence interval, 1.09-5.26).

Conclusion. Nasal surgery combined with upper airway RFA improved snoring with few complications in this series of patients with anatomic nasal obstruction with socially disruptive snoring. Reuse of RFA applicator tips at palatal sites reduces cost without an observed increase in the risk of upper airway infection.

Keywords

snoring, radiofrequency ablation, sleep surgery, septoplasty, inferior turbinate reduction

The spectrum of sleep-related breathing disorders (SRBD) includes snoring, upper airway resistance syndrome, and obstructive sleep apnea syndrome (OSAS). Socially disruptive snoring is frequently the presenting complaint with these disorders, and the prevalence of habitual snoring has been estimated to be as high as 25% in the general population.¹,² Therapeutic measures aimed to address SRBD depend on the severity of disease, comorbid conditions, patient anatomy, and patient preference. Nasal surgery combined with radiofrequency ablation (RFA) of the upper airway is a potential low-morbidity means to address socially disruptive snoring with associated nasal obstruction.

Nasal surgery for SRBD includes septoplasty, turbinate reduction, and nasal valve repair. These interventions are pursued for those who have failed topical medical therapies for nasal obstruction and have evidence of obstructive anatomy on physical examination. Septoplasty has been shown to reduce socially disruptive snoring through subjective measurements.³-⁷ However, nasal surgery only addresses one level of anatomical obstruction and is often not sufficient therapy for patients with SRBD due to the multilevel nature of the disorder.⁸,⁹

In contrast, RFA can be used to address multiple levels of anatomic obstruction. Radiofrequency ablation has a diverse role across medical disciplines, including the disruption of aberrant pathways of cardiac electrical activity, reducing growth of certain malignancies, and producing upper airway stiffening in SRBD. Radiofrequency ablation generates precise local inflammation and eventual fibrosis through low-temperature, high-frequency electrical current. The current initiates ionic agitation and subsequent low-temperature (<90°C) heat production, causing protein denaturation and coagulation.

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In palatal RFA, the tissue becomes stiffened and eventually volume contracted, thereby resulting in less tissue collapsibility and vibration during inspiration. First described the utility of RFA on the palate in patients with snoring, and subsequent studies to date have shown subjective improvements in snoring from 67% to 86% of patients. Radiofrequency ablation offers some significant advantages over traditional surgical options such as uvulopalatopharyngoplasty (UPPP). It is less invasive, has minimal postoperative pain, has minimal complications, and can be titrated to effectiveness with repeated treatments to enhance results. However, RFA generators may cost as much as $10,000, and the disposable tips average between $300 and $400 a piece. In patients receiving multiple RFA treatments, the continual cost of a new disposable tip each time may become financially prohibitive. The present study seeks to evaluate the use of nasal surgery combined with RFA in patients with socially disruptive snoring and determine the rate of infection with the reuse of RFA tip applicators.

Methods

Study design. This study is a retrospective case series of 130 adult patients evaluated at the Medical University of South Carolina (MUSC) Snoring Clinic who underwent nasal surgery and upper airway RFA for chronic nasal obstruction and socially disruptive snoring. Data included in this study were obtained from the electronic medical record of the Medical University of South Carolina, Charleston, and a quality assurance database in the MUSC Department of Otolaryngology–Head and Neck Surgery. The MUSC institutional review board (IRB) granted approval for this study.

Patient evaluation. All patients presented to the MUSC Snoring Clinic with a chief complaint of chronic nasal obstruction and severe snoring that was disruptive to their bed partner. All patients received a comprehensive sleep history and physical examination, including supine upper airway endoscopy. An overnight polysomnogram was recommended to all adult patients who presented with habitual, socially disruptive snoring. A polysomnogram was mandatory prior to treatment for any patient with a history of witnessed apneas, daytime somnolence or fatigue, obesity (body mass index [BMI] ≥30), an Epworth Sleepiness Scale score ≥10, or high blood pressure or other cardiovascular risk factors. Nasal surgery was offered to patients with chronic nasal obstruction who had failed at least a 4-week trial of topical nasal steroid therapy and who had anatomic evidence of a deviated nasal septum, inferior turbinate hypertrophy, and/or internal nasal valve collapse. Upper airway RFA was offered as an adjunct in patients with a history of chronic, socially disruptive snoring who had evidence of palatal and/or tongue base soft tissue collapse on awake supine fiber-optic Müller maneuver. Patients with moderate to severe sleep apnea (apnea hypopnea index [AHI] >15) underwent nasal surgery and upper airway RFA if they refused more extensive surgical procedures to improve snoring and nasal obstruction in the hope of improving future continuous positive airway pressure (CPAP) adherence. Continued CPAP therapy was recommended for all patients on CPAP following surgery unless a postoperative sleep study confirmed resolution (AHI ≤15) of significant apnea.

Upper airway surgery. Nasal surgery consisted of septoplasty with or without inferior turbinate reduction and/or nasal valve surgery. These surgeries were performed using standard surgical techniques. To perform RFA of the soft palate, a tonsil gag was inserted, bringing the palate into view. The soft palate was infiltrated with 8 to 10 cc of 1% lidocaine with 1:100,000 epinephrine. A single-prong RFA applicator (Somnus, Gyrus ENT, LLC, Bartlett, Tennessee; ProSleep, Celon, Berlin, Germany) was then used to create 6 lesions of 300 joules (J) each: 2 lateral lesions, 2 paramedian lesions, and 2 additional paramedical lesions at the junction of the hard and soft palates. Tongue base RFA was performed by first bringing the tongue base into view with a MacIntosh laryngoscope. The middle one-third of the tongue base was then infiltrated with 8 cc of sterile saline. Either a double-pronged tongue base RFA applicator (Somnus; Gyrus ENT LLC) or a single-pronged applicator (ProSleep; Celon) was then used to create 6 lesions spaced approximately 1 cm apart of 300 J each. All RFA applicators used in the operating room were then cleaned with an alcohol swab and placed in a bag labeled with the patient’s name for later follow-up use in the office. A percentage of patients with large uvulae (length >1.5 cm) underwent partial uvulectomy at the time of RFA to prevent postoperative uvular edema.

Postoperative course. After an initial postoperative follow-up within 3 days of surgery for septal splint removal and assessment of radiofrequency-treated sites, patients were seen 6 weeks after surgery and encouraged to undergo a second stage RFA of the palate and/or tongue in the office using the same applicator handpiece used at surgery. The procedure was performed while patients were sitting upright under local anesthesia. No antibiotic mouth rinses were used. The pharyngeal tissues were sprayed with topical 14% benzocaine followed by injection of 8 cc of 1% lidocaine with 1:100,000 epinephrine into the palate and/or tongue base site. The previously used RFA applicator was cleaned with an alcohol swab, after which a 6 RFA lesions of 300 J each was then applied in a pattern similar to the initial treatment. The RFA applicator was again cleaned with an alcohol swab and handed to the patient. In most cases, the patient was given a prescription for hydrocortone and a steroid taper pack if only a palatal site was treated. Patients treated at the tongue base received an additional 7-day prescription of antibiotics. Patients were instructed to call in the event of worsening pain, dysphagia, fever, or respiratory distress. A third appointment was scheduled 6 weeks later for third-stage RFA if patients had continued disruptive snoring and/or had ESS scores ≥10. At the final follow-up, bed partners were asked the following yes or no questions:

1. Does your bed partner still snore?
2. If so, is the snoring improved?
Patients also completed Epworth Sleepiness Scale (ESS) forms and the Functional Outcomes of Sleep Questionnaire (FOSQ).

**Statistical methods.** All analyses were performed with Sigma Stat 3.5, SPSS 15.0, and Sample Power 2.0 (SPSS, Inc, an IBM Company, Chicago, Illinois). All continuous variables were normally distributed as determined by the Kolmogorov-Smirnov test. Comparisons of baseline patient characteristics and clinical outcomes were performed using the χ² or Fisher exact test (categorical variables) and the t test (continuous variables). A P value of less than .05 was considered indicative of statistical significance.

**Results**

A total of 130 patients underwent nasal surgery and upper airway RFA for chronic nasal blockage and socially disruptive snoring between July 1, 2003, and June 30, 2010. The group consisted of 82 (63%) men and 48 (37%) women with a mean age of 50 years (range, 24-83 years). The diagnosis at the time of treatment was snoring without OSAS in 32 (25%) patients, whereas the remaining 98 (75%) had snoring with some degree of OSAS. In the patients with snoring with OSAS, the severity of OSAS was evenly divided among mild apnea (AHI 5-15) in 36 (37%) patients, moderate apnea (AHI 16-30) in 31 (32%), and severe (AHI >30) in 31 (32%). The mean (SD) preoperative AHI for the entire cohort was 18 (18.3).

Nasal septoplasty was performed on all 130 (100%) patients. Inferior turbinate reduction was done in 114 (88%) cases, whereas nasal valve repair was performed in only 6 (5%) cases. All patients received at least 1 application of upper airway RFA of either the soft palate (114 patients; 88%) or base of tongue (43 patients; 33%) in the operating room, with the majority (73%) undergoing at least 1 follow-up application in the clinic. In patients receiving palatal RFA, 31 (27%) had a single treatment, 37 (32%) had 2 treatments, 43 (38%) had 3 treatments, and 3 (3%) had 4 treatments. Tongue base RFA was performed as a single treatment in 39 (91%) patients, as 2 treatments in 3 (7%) patients, and 3 times in 1 (2%) patient. Uvulectomy was performed in 19 (15%) patients with long uvula (>1.5 cm length) where there was concern for possible posttreatment uvular edema.

The most common complication of upper airway RFA was mucosal ulceration (11%), which healed with saline gargles within 10 days to 2 weeks (Table 1). Ten patients (8%) had significant palatal or tongue edema, which interfered with speech and/or swallowing but resolved within a few days of starting a taper dose of steroids. One patient had a temporary paresis of the lingual nerve, which resolved a couple of weeks after tongue base RFA. This was attributed to a pressure neuropathy from the laryngoscope because the lingual nerve was not within the field of the RFA application. No patient had a severe or prolonged dysphagia preventing oral diet immediately after the procedure. Although the majority of patients (73%) received an RFA applicator tip that was reused in follow-up RFA applications in the office, there were no clinical cases of infection of the palate (n = 83) or tongue base (n = 4) after RFA therapy.

Bed partners were surveyed with regard to snoring outcomes after a median follow-up time of 144 days (25% quartile, 87 days; 75% quartile, 253 days). Most bed partners (94%) noted resolution or improvement in the snoring. Patients who underwent more than 1 RFA application were significantly more than twice as likely to have complete snoring resolution (odds ratio [OR] 2.39; 95% confidence interval [CI], 1.09-5.26) compared with patients who underwent a single application. Of the 65 patients with pre- and postoperative ESS score data, 49 improved, 9 worsened, and 7 stayed the same for an overall improvement in the mean ESS score from 6.7 ± 5.5 preoperatively to 5.8 ± 3.8 postoperatively (P = .0001). Of the 41 patients with pre- and postoperative FOSQ scores, 25 improved, 9 worsened, and 7 stayed the same for an overall improvement in the mean FOSQ score from 15.4 ± 4.1 preoperatively to 17.0 ± 3.1 postoperatively (P = .006). Postoperative sleep study values could not be assessed due to too few patients undergoing postoperative sleep studies.

**Discussion**

The present study demonstrates that nasal surgery combined with RFA improved snoring with minor complications in a group of patients with nasal obstruction and socially disruptive snoring. Assessment of bed partner satisfaction found that 94% of bed partners noted resolution (42%) or improvement (52%) of snoring. The authors are unaware of any studies that assess nasal surgery with RFA for direct comparison. A number of studies have evaluated nasal surgery alone for snoring. Low3 found that 15 of 30 patients had snoring relief after surgery, whereas Ellis et al4 found that of 126 patients, 39 (31%) had snoring resolution and 72 (57%) had improvement in snoring. A study by Fairbanks5 found that 77% of patients had elimination or improvement of snoring after nasal surgery. The results of the present study appear to

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**Table 1. Outcomes of Nasal Surgery and Upper Airway Radiofrequency Ablation**

<table>
<thead>
<tr>
<th>Procedure Complications</th>
<th>No./No. at Risk (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucosal ulceration</td>
<td>14/130 (10.7)</td>
</tr>
<tr>
<td>Palate edema requiring steroid</td>
<td>9/114 (7.9)</td>
</tr>
<tr>
<td>Tongue edema requiring steroid</td>
<td>1/43 (2.3)</td>
</tr>
<tr>
<td>Lingual nerve paresis</td>
<td>1/43 (2.3)</td>
</tr>
<tr>
<td>Prolonged dysphagia</td>
<td>0</td>
</tr>
<tr>
<td>Infection</td>
<td>0</td>
</tr>
<tr>
<td><strong>Snoring outcomes</strong></td>
<td></td>
</tr>
<tr>
<td>Unimproved</td>
<td>5/130 (3.8)</td>
</tr>
<tr>
<td>Improved, snoring still present</td>
<td>68/130 (52.3)</td>
</tr>
<tr>
<td>Resolved, no snoring</td>
<td>54/130 (41.5)</td>
</tr>
<tr>
<td><strong>No follow-up</strong></td>
<td></td>
</tr>
<tr>
<td>Median follow-up time, d (range)</td>
<td>144 (3-1710)</td>
</tr>
</tbody>
</table>
surpass success rates from nasal surgery alone. However, analysis is complicated by a number of factors. First, many different assessments of snoring resolution or relief have been used across studies, including visual analog scales (VAS), the Snore Outcomes Survey (SOS), and others. The authors believe that bed partner satisfaction assessment is the gold standard in measuring snoring relief. The possibility of a placebo effect and bias, however, cannot be thoroughly eliminated with the subjective nature of bed partner questioning concerning snoring outcomes. In addition, patients in the present study not only have nasal obstruction but also palatal and/or tongue base obstruction. It is not clear what percentage of patients in the aforementioned studies assessing nasal surgery alone also had upper airway soft tissue obstruction.

The present study does not show a higher rate of complications when combining nasal surgery with RFA as compared with RFA alone. The overall complication rate was 23.2%. This is in keeping with published complication rates of RFA. All complications in this study except for one are considered minor as classified by Kezirian et al. in 2005, and the only moderate complication was attributed by the authors to laryngoscopic pressure neuropathy and not the RFA application. The complication rate was consistent with the literature review by Kezirian et al. but higher than the accompanying prospective study. This may be due to the fact that many patients received multiple RFA treatments (mean of 2.2), which may increase the probability of a mucosal ulceration or more significant edema, given the repeated trauma to the tissue. However, repeated RFA treatments do increase the likelihood of complete snoring resolution. Further analysis is warranted to address the risks and benefits of multiple RFA treatments. Other proposed factors affecting the RFA complication rate are the learning curve of individual surgeons, energy delivered per lesion, temperature selection, anatomical site treated, and perioperative steroid use. The literature supports a higher rate of more serious complications from tongue base RFA, with some recommending overnight admission in these patients as a result. Further studies are warranted to assess what prognostic factors predict complication rates.

The ideal snoring treatment would result in a high rate of bed partner satisfaction, be applied in an outpatient and minimally invasive setting, result in minimal morbidity, and be cost-effective. To address the cost of RFA treatments, the reuse of RFA applicator tips was assessed in this study. Although 73% of the patients in the study received repeat RFA treatments with the same applicator tip, there were no cases of infection in the 83 patients undergoing repeated palate and 4 patients receiving repeated tongue base RFA. This is the only study known to the authors that assesses the reuse of applicator tips in RFA. Substantiating the safety of reusing RFA applicator tips could result in significant cost reduction for patients who require multiple RFA treatments to gain satisfactory reductions in snoring. Although no infections were observed in the 4 patients who had repeated tongue base RFA, these numbers are too few to draw firm conclusions concerning the safety of repeated use in the tongue base, especially given the potential of serious adverse events such as tongue base abscess and airway compromise. The present study agrees with earlier studies that multiple RFA treatments are more likely to have better results than single RFA treatments, which validates investigation of reusing applicator tips. Further studies with more patients are necessary to confirm the low rate of infection and safety at all upper airway sites, as well as assess the variety of different types of RFA devices being used.

The principal limitation of this study is the short mean follow-up time of 7.7 months (median 144 days). The long-term effects of nasal surgery combined with RFA need to be more thoroughly examined, as RFA has recently been shown to have only a 25% satisfaction score at 3 to 4 years posttreatment. The mixture of procedures prevents determination of the role of any single procedure in snoring reduction but is unavoidable given the multilevel nature of snoring and the need to address all potentially contributing sites at the time of surgery. Another limitation of this study is the small number of pre- and postoperative sleep studies, ESS, and FOSQ. Because there is no universally agreed upon measurement by which to measure snoring outcomes, it is prudent to assess a variety of outcomes to facilitate analysis across studies. Although patients and partners often consider snoring separately from underlying OSAS, it is imperative for the treating surgeon to ensure patient safety by encouraging ongoing therapy for significant OSAS even if snoring is improved to a level satisfactory to the patient and partner. Ideally, pre- and postoperative sleep studies would be obtained before and after any surgical intervention to better assess the results of that particular intervention, but this is rarely achievable in reality because of a high rate of patient refusal and/or limitations for repeat studies placed by insurance carriers.

Conclusion

Nasal surgery combined with upper airway RFA improved snoring with few complications in this series of patients with anatomic nasal obstruction with socially disruptive snoring. Reuse of RFA applicator tips reduced cost without increasing the risk of upper airway infection in this limited sample of patients. Additional study is needed to determine the long-term effectiveness of this strategy for snoring management.

Author Contributions

William Carroll, data collection, data analysis, manuscript preparation; Christina S. Wilhoit, data collection, data analysis, manuscript preparation; Jared Intaphan, data collection, data analysis, manuscript preparation; Shaun A. Nguyen, data collection, data analysis, manuscript preparation; M. Boyd Gillespie, design, data collection, data analysis, manuscript preparation.

Disclosures

Competing interests: M. Boyd Gillespie received a Gyrus-Olympus research grant for sleep endoscopy. Shaun A. Nguyen received a research grant studying tinnitus from Merz and is a
coinvestigator on a research grant studying sleep endoscopy for Gyrus-Olympus.

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