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The efficacy of radiofrequency volumetric tissue reduction of hypertrophied inferior turbinate in simple snoring

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Abstract. – BACKGROUND: Simple snoring represents a social problem, not only because it could affect the patient's married life, but it often goes along with sleep-disordered breathing. Chronic nasal obstruction has many sequel including snoring and the inferior turbinate hypertrophy (ITH) is its most common cause. The aim of the study is to evaluate the efficacy of video-assisted endoscopic radiofrequency volumetric tissue reduction *(RFVTR)* to reduce snoring in patients affected by chronic nasal obstruction due to ITH.

PATIENTS AND METHODS: This prospective study was conducted over 48 habitual snoring with persistent nasal obstruction due to bilateral ITH refractory to medical management received one time *RFVTR* of both it. Nasal symptoms were assessed both subjectively, by Visual Analog Scale (VAS) and NOSE Scale, and objectively by videorhinohygrometer. Snoring was measured by Snoring severity rated by the bed partner, in a longitudinal fashion, using VAS. All patients were evaluated pre-operatively, and after 45th day (range 35-50 days) post-operatively.

RESULTS: Thirty-two subjects completed study. All patients had significant symptomatic improvement in nasal breathing (5.53 ± 2.88 vs 1.87 ± 1.75; $p < 0.05$), confirmed by videorhinohygrometer values ($p < 0.05$). We had a significantly improvement of snoring in all patients (5.62 ± 2.80 vs 1.86 ± 1.43, $p < 0.001$) with a mean snoring Visual Analog Scale improvement of 77.4%.

CONCLUSIONS: Based on this study and literature review, it seems that *RFVTR* represents a safe, minimal invasive, easy performed, and time and cost effective surgery, which may decrease symptoms of snoring in patients with ITH, at least, in short-term follow-up.

Keywords:
Snoring, Turbinate, Videorhinohygrometer, Endoscopic radiofrequency, Breathing.

Introduction

Sleep-disordered breathing (SDB) is a spectrum of various clinical entities ranging from primary snoring to severe obstructive sleep apnea (OSA)[1].

Primary snoring shows high prevalence among adults estimating that 20-57% population is affected[2,3]. It is not only a "cosmetic" issue but it compromises the quality of sleep of partner and is associated to an increased risk to develop OSA and OSA-correlated cardio-circulatory[4,5] and respiratory[6] conditions; Lee et al[7] reported a link between heavy snoring and carotid artery atherosclerosis and Deeb et al[8] recently showed that non-apneic snoring may be a precursor to changes of the carotid artery intima. The sound of snoring results from vibrations of soft upper airways tissues included uvula, the soft palate, and the pharyngeal walls and implies a decrease in upper airway diameter[9].

Although a link between nasal breathing and sleep as well as improvement of sleep quality following relief of nasal obstruction would seem intuitive, the literature is not conclusive in that respect despite the interest in the area, as demonstrated by the number of relevant articles published[10]; a standardization of methods and higher evidence level studies were evoked in recent papers to clarify the benefit of nasal interventions in the treatment of SDB[11,12].

Chronic nasal obstruction is a common symptom of nasal disease and it has many sequel including snoring[13,6].

In adults the commonest cause of nasal obstruction is represented by inferior turbinate hypertrophy (ITH)[14]. Some patients are refractory to medical management and in these instances a surgical inferior turbinate volume reduction may be proposed[15,16].

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Nowadays the most widely accepted surgical technique is the video-assisted endoscopic radiofrequency inferior turbinate volume reduction (RFVTR)[17,18].

The aim of this study is to evaluate the improvement of snoring after RFVTR in inferior turbinates' chronic hypertrophy.

Patients and methods

For the study 48 patients (29 Male, 19 Female, mean age 45 years, age range 22-55 years), from March to May 2013, with chronic nasal obstruction due to ITH candidates to endoscopic RFVTR were recruited. We excluded from the study patients with nasal polyposis, chronic rhinosinusitis, ongoing pregnancy, nosebleeds, patients who already underwent nasal surgery, patients with marked septal deviation, patients immunocompromised, patients with bronchial asthma or COPD, patients who had used antibiotics in the previous 30 days, patients that chronically use immunosuppressive/corticosteroid, patients with moderate OSAS. We also excluded patients with severe OSAS; in particular, we included in the study only primary snorers and mild obstructive sleep apnea subjects selected through two simple and rapid tools of screening: the Rome Questionnaire (RQ)[19] and the Stop Bang Questionnaire[20]. Of the 48 patients initially recruited, were finally included 32 patients (18 M, 14 F, mean age 51 years, age range 24-55 years) according inclusion criteria.

Each patient was subjected to the following procedures:

1. History and pre-and post-operative nasal endoscopic;
2. Pre-and post-operative nasal obstruction symptom evaluation (NOSE) Scale;
3. Subjective nasal respiratory evaluation through pre-and post-operative 10-score visual analog scale (VAS);
4. Subjective evaluation of snoring severity through pre-and post-operative 10-score VAS completed by bed partner;
5. Video-rhino-hygrometer (VRH).

The postoperative evaluation was performed on the 45 th day (range 35-50 days) after surgery.

The study protocol was approved by the Research Ethics Committee at our institution and every patient signed a written informed consent.

Table I. The Rome Questionnaire.

1. **Have you ever noticed apneas (breathing pauses) during your husband/wife's sleep?**
   Yyes (= 10 points) ☐ No (= 0 points) ☐
2. **Have you ever noticed respiratory distress during your husband/wife's sleep?**
   Yes (= 10 points) ☐ No (= 0 points) ☐
3. **Have you ever had to shake your husband/wife while sleeping in order to make him/her resume breathing?**
   Yes (= 10 points) ☐ No (= 0 points) ☐
4. **When you observe your husband/wife sleeping, do you fear he/she can have an apnea?**
   Yes (= 10 points) ☐ No (= 0 points) ☐
5. **How frequently does your husband/wife suffer badly from a sore throat?**
   Never (= 0 points) ☐ Once a month (= 2 points) ☐ Once a week (= 4 points) ☐
   More than once a week (= 6 points) ☐ Nearly every day (= 8 points) ☐ Always (= 10 points) ☐
6. **Does your husband/wife breath with their mouth during the day?**
   Never (= 0 points) ☐ Rarely (= 2 points) ☐ Sometimes (= 4 points) ☐
   Often (= 6 points) ☐ Nearly always (= 8 points) ☐ Always (= 10 points) ☐
7. **Does your husband/wife complain of daytime sleepiness while he/she driving the car?**
   Never (= 0 points) ☐ Rarely (= 1 points) ☐ Sometimes (= 2 points) ☐
   Often (= 3 points) ☐ Nearly always (= 4 points) ☐ Always (= 5 points) ☐

Rome questionnaire

The *RQ* (Table I) is a questionnaire designed by M. Casale et al[19], used for the first time in a study conducted between 2004 and 2006 at the area of Otolaryngology of the Campus Bio-Medico of Rome. It's simple and fast (it can be completed in just 5 minutes) and it's administered, after written consent of the patient, to his partner. The questionnaire is based on 7 closed questions, which consist of short and clear sentences to investigate the presence of risk factors for OSAS, formulated using simple and common words. For each question is allowed only one answer: questions from 1 to 4 have two possible alternatives, while in questions from 5 to 7 six options are given. The total score (min 0; max 65) is calculated by adding the scores given for each question. By analyzing the total score, it was seen that patients with moderate-severe OSAS in 66% of cases show a score > 40 while in no case their score is < 20 (Table I).

Questionnaire STOP-BANG

The STOP-Bang questionnaire (Table II) is a pre-operative screening tool for OSAS. Its name is an acronym of the initial of the 8 questions provided by the test. The questionnaire is composed by simple closed questions that provide an affirmative (Yes, score 1) or negative (No, score 0) response. So the total score ranges from a minimum of 0 to a maximum of 8. In particular, it has been shown as a score ≥ 3 has a high sensitivity in detecting OSAS: 93% and 100% respectively for moderate and severe OSAS[20] (Table II).

History and nasal endoscopic

History and nasal endoscopic with flexible nasal fiber endoscope were carried out to elicit information relevant to inclusion and exclusion criteria, focusing on the nasal breathing quality. All included patients candidates to RFVTR showed severe or obstructive inferior turbinate hypertrophy, according classification showed in Figure 1.

NOSE Scale

The NOSE scale (Table III) is a standardized questionnaire that analyzes the quality of life for the last 4 weeks related nasal obstruction. This scale is brief, valid, reliable and responsive. It consists of five questions that have as possible answer a series of values from 0 to 4, where at a low value corresponds a situation of poor symptomatology or normality, while at an high value corresponds an accentuated symptomatology[21] (Table IV).

Table II. Questionnaire STOP-Bang.

1. Snoring: Do you snore loudly (louder than talking or loud enough to be heard through closed doors)? YES - NO

2. Tired: Do you often feel tired, fatigued, or sleepy during daytime? YES - NO

3. Observation of sleep: Has anyone observed you stop breathing during your sleep? YES -NO

4. Blood pressure: Do you have or are you being treated for high blood pressure? YES - NO

5. BMI: Do you have a BMI more than 35? YES - NO

6. Age: Do you have more than 50? YES - NO

7. Neck circumference: Do you have a neck circumference greater than 40 cm? YES – NO

8. Gender: Gender male? YES - NO

HIGH RISK OF OSAS: answering YES to 3 or more items

LOW RISK OF OSAS: answering YES to less than 3 items.

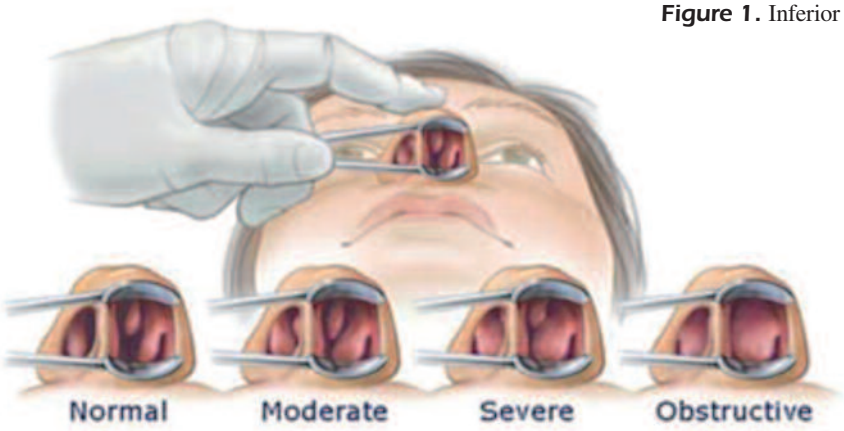

Figure 1. Inferior turbinate hypertrophy classification.

Visual analog scale

The VAS consists of a graduated scale with values from 0 to 10, whereas 0 corresponds to no symptoms and 10 corresponds to a feeling of maximum syntomatology. The VAS on nasal breathing (Figure 1) is directly administered to the patient, who has to assess his nasal obstruction considering one nostril at a time; so the patient is asked to close one of its two nostrils with his finger before giving the score to the airflow through the contralateral free nostril. The VAS on the snoring is administered to bed partner, who has to give a score to his mate's snoring.

Video-rhino-hygrometer

The VRH is a diagnostic tool whose purpose is to quantify in a simple, rapid and non-invasive way the nasal obstruction that has recently obtained European patent (PCT/GB 2006/000251). It is based on image processing of the condensation halos formed on a slab after nasal exhalation. The scene is recorded by a video camera and the video stream is processed, frame by frame, to extract several quantitative parameters useful for clinical investigation. All these data are saved on a profile associated with the individual patient[22].

Over the past 1 month, how much of a problem were the following conditions for you?

Please circle the most correct response

	Not a problem	*very mild problem*	*moderate problem*	*fairly bad problem*	*severe problem*
1. Nasal congestion or stuffiness	0	1	2	3	4
2. Nasal blockage or obstruction	0	1	2	3	4
3. Trouble breathing through my nose	0	1	2	3	4
4. Trouble sleeping	0	1	2	3	4
5. Unable to get enough air through my nose during exercise or exertion	0	1	2	3	4

Table III. The NOSE scale.

Table IV. VAS scale.

Take a few breaths through your free nostril and circle the number that best represents how at this time the air is going through your nose. Repeat on the other nostril.

Left	*The air freely passes through my nostril*	Right
0	↑	0
1	↕	1
2	↕	2
3	↕	3
4	↕	4
5	↕	5
6	↕	6
7	↕	7
8	↕	8
9	↕	9
10	↓	10
	The air doesn't passes through my nostril	

A typical VRH session is arranged as follows: in the beginning the patient puts his/her chin on a suitable rest; the plate is positioned under the nostrils in a horizontal position, in such a way that the vertical axis of the plate is 90° toward the upper lip and straight under the columella. The camera then starts to register the scene. The patient is asked to breath normally over the steel plate for a limited time (generally for no less than five respiratory acts). During this period, because of the different temperature between the expired airstream and the thermoregulated plate, a condensation phenomenon rises on the surface causing the impression. It must be noticed that to have reliable and comparable results, the reference temperature of such surface is dynamically set up in accordance with environmental parameters (e.g., temperature and humidity)[23], (Figure 2)

Surgical Procedure

The patients were subjected to RFVTR. To deliver this energy we used the Somnoplasty System (Somnus Medical Technologies, Inc., Bartlett, TN, USA) and the SP 1100 turbinate handpiece (40-mm-long needle electrode consisting of a distal 15-mm active portion and a proximal 25-mm insulated part) with thermocouples within the electrode to allow the surgeon feedback during treatment: this included tissue temperature, power used, and total energy delivered. Before the treatment, a cotton pledget soaked with mepivacaine and adrenaline solution was introduced into each inferior meatus. The patient was placed in the supine position and after 10 minutes, under 0° and 30° endoscopic vision, the active 10-mm portion of the electrode and at least 2 mm of the insulation were inserted submucosally while the energy was delivered into three different sites of each turbinate (anterior, middle, and posterior portion). The energy delivered for each puncture was 300 J with an average duration of 59 ± 16 seconds and a plateau tissue temperature of 75 ±

Figure 2. A, VRH instrument; **B**, elaboration of condensation halos of the airflow of each nostrils on the thermoregulated plate.

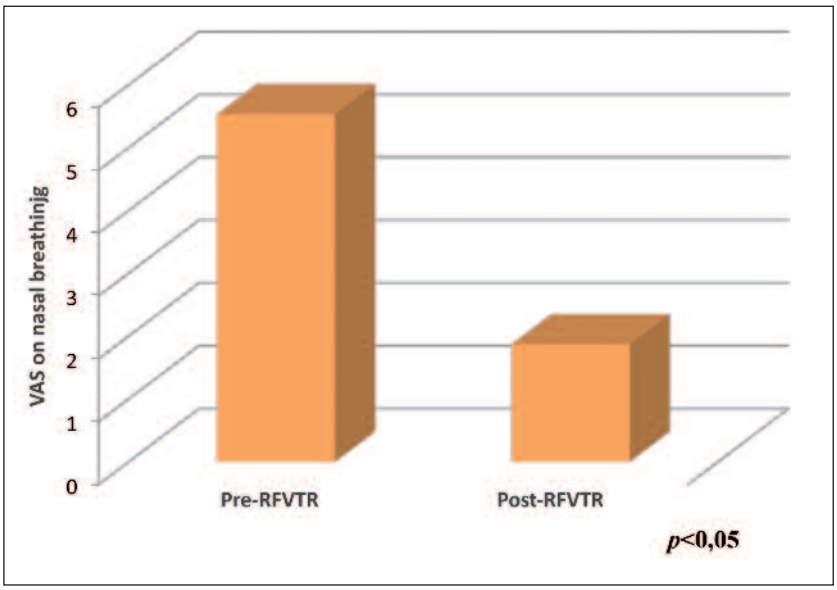

Figure 3. Comparison of VAS scores on nasal breathing pre-and post-RFVTR.

5.6°C. After treatment, all patients were discharged without any limitation of normal daily activities and no nasal pack was needed.

To speed up the improvement of nasal breathing and to reduce the postoperative discomfort of the patient, from the first until the fourteenth day after the procedure nasal cavities' washing were carried out. For a total of 2 weeks, patients have therefore taken twice a day 3 ml of hyaluronic acid (Yabro, IBSA Farmaceutici Italy, Lodi, Italy) dissolved in 2 ml of isotonic solution. The self-administration of the substance occurred through Rinowash (Air Liquide Medical Systems SpA, Bovezzo, Italy), a nebulizer designed for the treatment of upper airway which creates micronized particles[24].

Statistical Analysis

Statistical analysis was performed using the non-parametric test for paired data according to Wilcoxon. In view of the objectives of the study, were analyzed data derived from the test with the VRH: the VRH R/L sum of the two areas and the VRH Rate. The collected data were expressed as mean and SD. p values < 0.05 were considered significant.

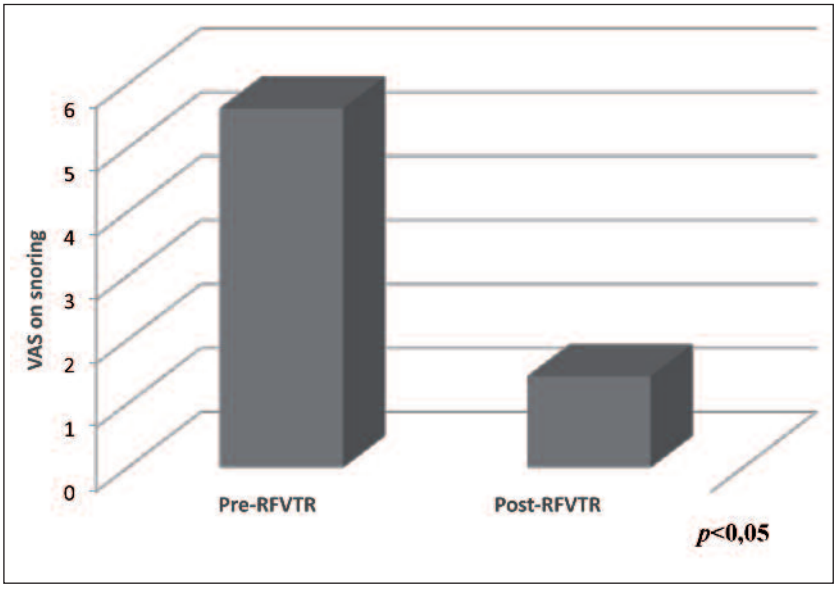

Figure 4. Comparison of VAS scores on snoring pre-and post-RFVTR.

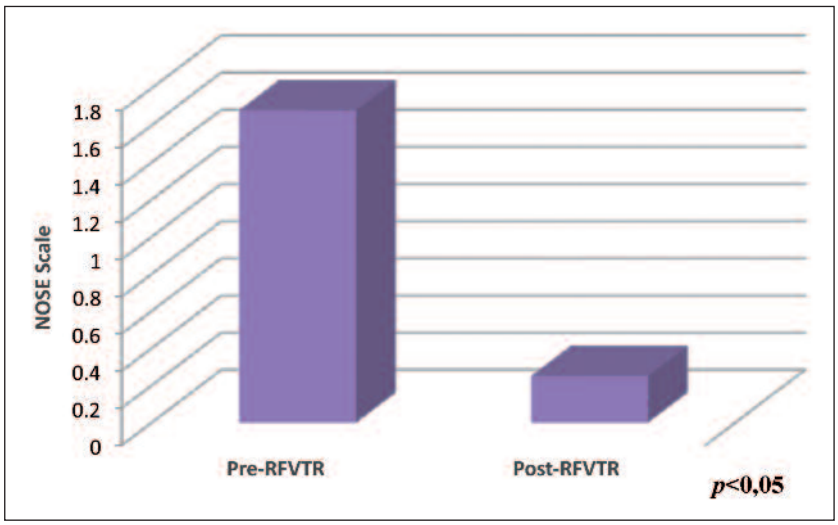

Figure 5. Comparison between pre- and post-RFVTR values obtained to NOSE Scale on the nasal respiratory distress.

Results

Comparing pre-and post-surgical mean VAS scores of nasal breathing (5.53 ± 2.88 vs 1.87 ± 1.75) and those of VAS inherent snoring (5.62 ± 2.80 vs 1.86 ± 1.43), a statistically significant improvement ($p < 0.05$) emerged (Figures 1 and 2). Even the values obtained to NOSE Scale on the nasal respiratory distress before and after surgery (1.68 ± 0.25 vs 1.44 ± 0.57) decreased post-operatively in a statistically significant way ($p < 0.05$) (Figure 3). This subjective improvement was confirmed by the significant post-operatively increase of VRH halo sum (27.079 ± 15.601 vs 45.857 ± 23.670) (Figure 4). All included patients showed an improvement in VAS snoring (5.62 ± 2.80 vs 1.86 ± 1.43, $p < 0.001$) with a mean snoring VAS improvement of 77.4% (Figures 3, 4, 5, 6).

Discussion

Most people have experienced sleeping difficulty during episodes of virally induced nasal congestion and yet Hippocrates in "De Morbis Popularibis" noted that nasal polyps were associated with restless sleep[25]. Indeed, the nose accounts for more than 50% of the total resistance of the upper airway[26,10].

Physiological mechanisms that explain the relationship between nasal airflow and breathing during sleep include the Starling resistor model, unstable oral breathing, nasal-ventilatory reflex and NO delivery reduction; this model predicts that a further obstruction upstream (nose) will generate a suction force (negative intraluminal pressure) downstream (oropharynx) resulting, in predisposed individuals, in oropharyngeal collapse. This effect is exacerbated

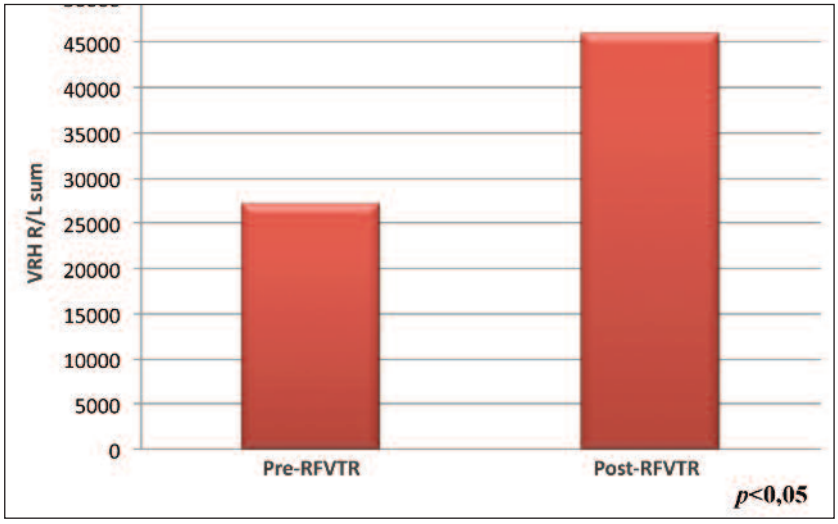

Figure 6. Comparison of pre- and post-surgical VRH R/L sum.

at the supine position, when nasal resistance tends to increase both actively due to postural reflex mechanisms as well as passively as a result of the reduced hydrostatic pressure on nasal venous circulation[27,28].

SDB is a spectrum of various clinical entities ranging from primary snoring to severe obstructive sleep apnea (OSA)[1].

Primary snoring shows high prevalence among adult population[3,29]. It is not only an aesthetic problem and a compromising factor of bed partner's quality of sleep, but it also may represent an important risk factor for the development of cardio-circulatory and respiratory diseases[4,5]. Our data point out that the improvement of nasal breathing post RFVTR, shown by pre- and post-operative subjective tools and by innovative VRH, is associated with an important snoring reduction as testified by bed partner. The limits of our study are the lack of objective measures of snoring and the short follow-up. Nevertheless the subjective improvement in the intrusiveness of snoring, as noted by the bed partner, is important. Furthermore it should be stated that with the present study we wanted to emphasize the rapid snoring improvement after *RFVTR*, a mini-invasive procedure executable also in ambulatory setting with usually long lasting results even if easily repeatable in case of ITH recurrence.

The encouraging results of this study must be confirmed by further studies on a larger scale in the future, included the objective evaluation of snoring and a longer term follow-up.

Conflict of interest

M. Casale and F. Salvinelli are inventors of videorhinohygrometer (PCT/GB 2006/000251). The other authors have no conflict of interest.

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