Eur Arch Otorhinolaryngol (2006) 263: 164–170
DOI 10.1007/s00405-005-0959-5

MISCELLANEOUS

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Radiofrequency tissue volume reduction of the soft palate and UPPP in the treatment of snoring

Received: 16 September 2004 / Accepted: 10 February 2005 / Published online: 16 December 2005

Abstract The purpose of this study was to evaluate the efficiency of radiofrequency tissue volume reduction (RFTVR) and uvulopalatopharyngoplasty (UPPP) in the treatment of snoring in a prospective clinical trial of 79 patients consecutively undergoing surgery for snoring. Seventy-nine patients with primary snoring or mild OSAS (obstructive sleep apnea syndrome) were enrolled in this clinical trial (66 males and 13 females). According to the anatomical findings (the size of the tonsils and uvula), the patients underwent UPPP/TE of the RFTVR of the soft palate. Forty-seven patients had UPPP/TE (age 45.81 ± 12.11 years; median AHI: 8; range 1–29). Thirty-two patients were treated with RFTVR of the soft palate (age 48.10 ± 10.92; median AHI: 5.0; range 0–26). The average number of treatments was 2.2. All patients underwent preoperative polysomnography to exclude severe OSAS. Pre- and postoperative snoring scores were evaluated from the patients with bed partners. Postoperative follow-up data were collected at a median of 4 months after treatment; 85.1% of the UPPP group and 53.1% of the RFTVR group underwent postoperative polysomnography. Subjective snoring scores of all study participants were evaluated. Preoperatively, there was no statistically significant difference of subjective symptoms, age and BMI between the two groups. The snoring scores improved statistically significantly in both groups ($P < 0.001$ in the UPPP group; $P = 0.001$ in the RFTVR group). After UPPP/TE snoring improved in 37 patients (78.7%), and 29 (61.7%) thereof were free of bothersome snoring; no change was found in 9 patients (19.2%), and 1 (2.1%) worsened. In the RFTVR group, snoring improved in 15 (46.9%), and 9 (28.1%) thereof were free of bothersome snoring; no change was found in 13 patients (50%), and 1 worsened (3.1%). Preoperative AHI was statistically higher ($P = 0.016$) and mean minimal oxygen saturation significantly lower ($P = 0.002$) in the UPPP group. In the UPPP group AHI and HI showed statistically significant improvement postoperatively ($P = 0.025$ and $P = 0.034$, respectively). After RFTVR, no statistically significant change of AHI, HI or oxygen saturation was found. Besides limited mucosal erosions (15%) after RFTVR and foreign body sensations (< 10%) after UPPP/TE, no side effects were observed. The success rate of RFTVR of the soft palate is lower compared to the more invasive technique of UPPP. Due to its minimally invasive character, RFTVR is suitable as first-step treatment for snoring, but patients should be counseled about possible success rates and different treatment options.

Keywords Radiofrequency · Uvulopalatopharyngoplasty · UPPP · Snoring · OSAS

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Introduction

The problem of snoring and OSAS (obstructive sleep apnea syndrome) has gained increased awareness in the media and general population during recent years. The prevalence of occasional snoring varies from 29 to 71% [5, 8, 14] and of habitual snoring from 9 to 26% [13, 17, 18]. The more severe disease of OSAS has a prevalence of up to 4% for men and 2% for women according to Young et al. [22]. The gold standard treatment for severe OSAS is NCPAP (nasal continuous positive airway pressure). Primary snoring without significant apneas can be a socially unacceptable problem when bed part-

ners suffer from heavy snoring and ''leave the bedroom.'' Therefore, an increasing number of patients seek treatment. Besides general sleep hygiene, loss of weight and mandibular advancement devices, surgical procedures can reduce snoring.

The use of radiofrequency energy for volumetrical soft tissue reduction of the palate was first described by Powell et al. [16]. Energy generated via a mono- or bipolar electrode needle causes ablation and coagulation of the soft tissue, followed by fibrosis and shrinkage of the soft palate. This reduction of soft tissue volume can reduce snoring.

So far, a number of studies have been published about the efficiency of RFTVR, but only one study directly compared the results with patients undergoing LAUP (laser-assisted uvulopalatoplasty) [20]. The present study is the first prospective study to compare the efficiency of RFTVR of the soft palate with patients undergoing UPPP in the treatment for snoring. Patients of the two study groups were not randomized.

Materials and methods

Setting

The setting was a university hospital center with a catchment area of a population of 1.5 million in urban and rural areas.

Methods and techniques

Patients complaining about severe socially disturbing snoring seen at the outpatient clinic for sleep-related breathing disorders at the Department of Otorhinolaryngology, the Medical University of Graz, were considered to take part in the study. Preoperatively, all patients underwent at least seven line polysomnography studies. Patients with AHI > 30/h and mean oxygen desaturation $< 65\%$ O^2 indicating OSAS were excluded from the study. All patients underwent clinical examination including the Mueller maneuver with flexible endoscopy of the naso- and hypopharynx. Seventy-nine patients with primary snoring or mild OSAS were enrolled in the study and underwent surgical treatment for snoring. Patients with hypertrophy of the tonsils or a uvula touching the base of the tongue underwent UPPP ($n = 47$). Thirty-five patients underwent UPPP with tonsillectomy and 12 without tonsillectomy. Criteria to undergo RFTVR were having small, non-hypertrohic or absent tonsils and a uvula not touching the base of the tongue ($n = 32$).

Subjective snoring scores were evaluated from the patient together with the bed partner via a visual snoring scale (0 = no snoring; 1 = snoring not bothersome for the bed partner; 2 = snoring bothersome; 3 = bed partner leaves the bedroom; Table 1). At a median of 4 month postoperatively, subjective symptoms were evaluated.

Table 1 A visual analog score 0–3 was used to evaluate the subjective snoring score

	Score
No complaint of snoring	Grade 0
Occasional snoring, not bothersome for bed partner	Grade 1
Habitual, loud snoring, bothersome for bedpartner	Grade 2
Habitual, loud snoring, bed partner leaves bedroom	Grade 3

Of the UPPP patients 85.1% ($n = 40$) and of the RFTVR patients 53.1% ($n = 17$) underwent polysomnography follow-up. Seven patients of the UPPP group and 15 patients of the RFTVR group refused to undergo postoperative sleep studies. Statistical analyses of the data were conducted at the Institute for Medical Informatics, Statistics and Documentation at the Medical University of Graz.

RFTVR technique

The patient was placed in a sitting position and a grounding plate was fixed on the left upper arm. After application of xylocain spray to the soft palate and posterior pharyngeal wall, the soft palate was infiltrated with 5 ml of xylocain 2% with epinephrine 1:100,000. A monopolar radiofrequency electrode (Somnoplasty, SP 1010, Somnus Medical Technologies, Gyrus ENT, Bartlett, USA) was placed in the submucosal layer of the soft palate at three different sites, first in a median line above the uvula, then paramedian in the direction towards the tonsil niches (Fig. 1). An energy of 700 J to the median area and 350 J each to the paramedian areas, with a mean of 4–6 W at a temperature target of 70–85° C was applied. The parameters of Joule (Watts × seconds), temperature and time were controlled via a monitor throughout the whole procedure.

The procedure lasted for 15 to 20 min, and all patients were treated as outpatients. Postoperative pain was treated with oral diclofenac 150 mg daily. The treatment was repeated after 6 weeks, and up to three treatments per patient were performed. Fewer than three treatments were given when the patients were satisfied or refused further treatments. The mean number of treatments received was 2.2 per patient.

UPPP technique

Patients were admitted 1 day preoperatively for preoperative medical examination. For optimal postoperative pain control and possible postoperative bleeding, patients are routinely discharged on the 3rd postoperative day after tonsillectomy at our department. This results in a 5-day hospitalization of all patients undergoing UPPP/TE. The procedure was performed under general anesthesia. If the tonsils were present a tonsillectomy was first performed, then redundant soft tissue from the free margin of the soft palate was resected. The muscles of the anterior and posterior pillars were always pre-

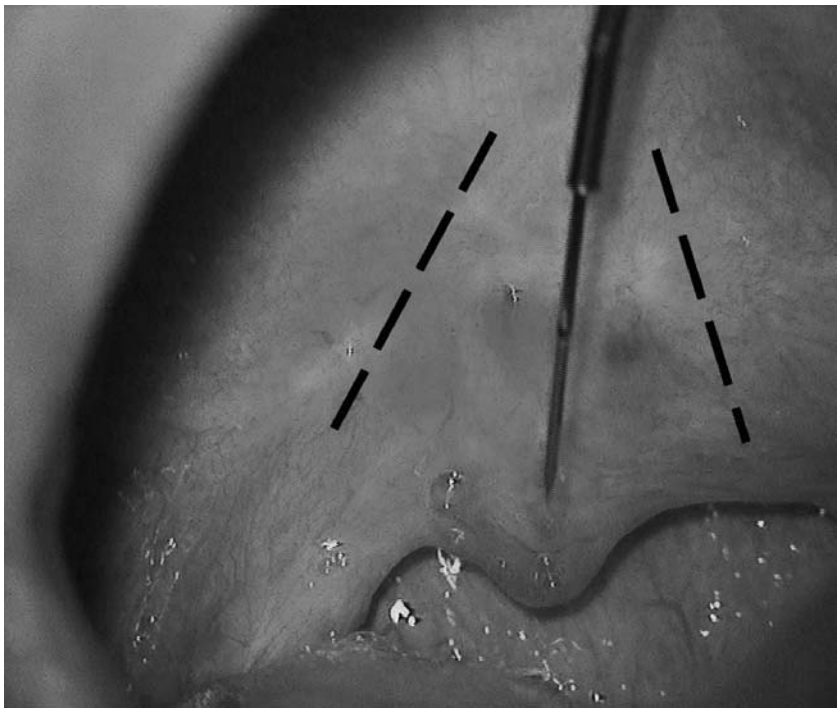

Fig. 1 The monopolar radiofrequency electrode (Somnoplasty, Somnus Medical Technologies, Gyrus ENT, Bartlett, USA) was placed in the submucosal layer of the soft palate in three different sites: first in a median line above the uvula, then paramedian towards the tonsil niches (*interrupted lines*)

served. Finally, the uvula was resected, while the uvula muscle was preserved. The mucosal margins were sutured with vicryl 3.0. Routinely no local anesthesia or intraoperative corticosteroids were given. On the day of surgery and 2 days postoperatively the patients received i.v. diclofenac. After discharge pain was controlled with oral diclofenac 150 mg daily for 7 to 14 days.

Statistical analysis

Averages for patients' age, BMI, mean minimal and lowest oxygen saturation are reported as the means with standard deviation in parentheses. For all other variables averages were given as the median with minimum and maximum in parentheses. Comparisons between the groups were performed using the Mann-Whitney U test for continuous variables, except for age, where Student's *t* -test was applied. For comparisons between pre- and postoperative data, the Wilcoxon test was used. Chi-square analyses or Fisher's exact test were used for categorical data. All analyses were carried out with the statistical software SPSS (version 11). *P* -values less than 0.05 were considered statistically significant.

Results

Study groups

Seventy-nine patients were enrolled in the study (66 males and 13 females). Forty-seven patients underwent UPPP/TE (age 45.81 ± 12.11; BMI 28.06 ± 3.841; median preoperative AHI 8.00, range 1–29), and 32 patients were treated with RFTVR (age 48.10 ± 10.92; BMI 26.45 ± 2.850; median preoperative AHI 5.00, range 0–26) (Table 2). There was no statistically significant difference of BMI, age or subjective symptom scores between the two groups. The preoperative AHI was significantly higher ($P = 0.016$) and mean minimal oxygen saturation significantly lower ($P = 0.002$) in the UPPP group.

Table 2 Preoperative characteristics of 79 patients who were enrolled in the study. Forty-seven patients underwent UPPP and 32 were treated with RFTVR. The preoperative median AHI was statistically significantly higher in the UPPP group, the mean minimal oxygen saturation significantly lower compared to the RFTVR group

	UPPP ($n = 47$)	RFTVR ($n = 32$)	
Sex	43 male (91.5%) 4 female (8.5%)	23 male (71.9%) 9 female (28.1%)	
Age (mean, SD)	45.81 ± 12.111	48.10 ± 10.919	$P = 0.386$
BMI (mean, SD)	28.06 ± 3.841	26.45 ± 2.85	$P = 0.070$
AHI (median, range)	8.00 (1–29)	5.00 (0–26)	$P = 0.016$
AI (median, range)	2.00 (2–16)	2.00 (0–10)	$P = 0.090$
HI (median, range)	5.00 (0–19)	3.00 (0–23)	$P = 0.095$
Mean minimal oxygen saturation (mean, SD)	86.56% ± 5.185	89.75% ± 3.11%	$P = 0.002$

Subjective snoring scores

Postoperatively, a statistically significant improvement was found in both treatment groups ($P < 0.001$ in the UPPP group and $P = 0.001$ in the RFTVR group). After UPPP, 29 (61.7%) of the patients were free of bothersome snoring, in 8 (17%) snoring improved, but was still bothersome; in 9 (19.2%) no change of snoring habits was found; in 1 patient (2.1%) a deterioration of snoring was found (Fig. 2). The number of grade 3 snorers was reduced from 37 (78.7%) to 8 (17.0%) (Fig. 3a). Postoperatively, 24 (51.1%) patients had non-bothersome snoring, and 5 (10.6%) were free of snoring (Fig. 3a). In the RFTVR group, 9 (28.1%) were free of bothersome snoring; in 6 (18.1%) snoring decreased, but was still bothersome; in 16 (50.0%) of the patients no change was found (Fig. 2). In one patient (3.1%), snoring became worse. The number of grade 3 snorers was reduced from 28 (87.5%) to 15 (46.9%) (Fig. 3b). Eight patients (25.0%) reported non-bothersome snoring, and one patient (3.1%) was free of snoring after treatment (Fig. 3b)

Polysomnography follow-up

Of the UPPP group 85.1% (40) and of the RFTVR group 53.1% (17) underwent postoperative polysomnography follow-up. In the UPPP group the median AHI was reduced from 8.00 (range 1–29) to 5.00 (range 0–26) (Fig. 4). The postoperative reduction of AHI ($P = 0.025$) and HI ($P = 0.034$) was statistically significant (Table 3).

After RFTVR the median AHI changed from 6.00 (range 0–14) to 9.00 (1–21) (Fig. 4). The change of polysomnography data in this group was not statistically significant (Table 3). The median duration of pain was 3 (range 0–22) days after RFTVR and 10 (range 1–21) after UPPP.

Side effects

After UPPP four patients (8.5%) complained of foreign body sensations in the soft palate area, one patient had difficulty swallowing tablets 2 months postoperatively (2.1%), and one patient complained of tinnitus after the operation. After RFTVR erosions of the mucosa occurred in five patients (15.6%); these healed after 10–20 days. One patient needed i.v. corticosteroid treatment for swelling of the uvula on the 1st postoperative day. No long-term sequelae were observed in either group.

Discussion

UPPP [7, 11] and LAUP [12] are common techniques in the treatment for snoring with success rates of 80–85% [6, 9, 15] and 75–80% [15], respectively. The most recently developed surgical technique for snoring is RFTVR (radiofrequency tissue volume reduction) of the soft palate, which was introduced by Powell in 1998 [1, 2, 3, 10, 16, 19, 20]. The present study is a prospective study on the efficiency of soft palate RFTVR and UPPP (uvula-palato-pharyngoplasty). All patients suffered from primary socially unacceptable snoring or mild OSAS preoperatively.

Snoring scores improved statistically significantly in 78.7% of the patients undergoing UPPP and in 46.9% of the patients treated with RFTVR. Free of bothersome snoring were 61.7% of the UPPP patients and only 28.1% of the RFTVR patients. These results are based on subjective snoring scores evaluated by patients and their bed partners. Unfortunately, standardized equipment to measure and objectify snoring noise is not yet available. Another problem is variation of snoring from one night to another, and sleep quality is different from home in the hospital or a sleep laboratory. Therefore, to evaluate snoring, one has to rely on snoring scores of patients and their bed partners. Nevertheless, satisfaction of the patients and bed partners is the aim of surgical treatment for snoring and therefore can be regarded as the criterion of success.

Due to more excessive tissue of the upper airway in the UPPP group, significantly higher preoperative scores of AHI and mean minimal oxygen saturation existed in the UPPP group of the present study. Postoperative

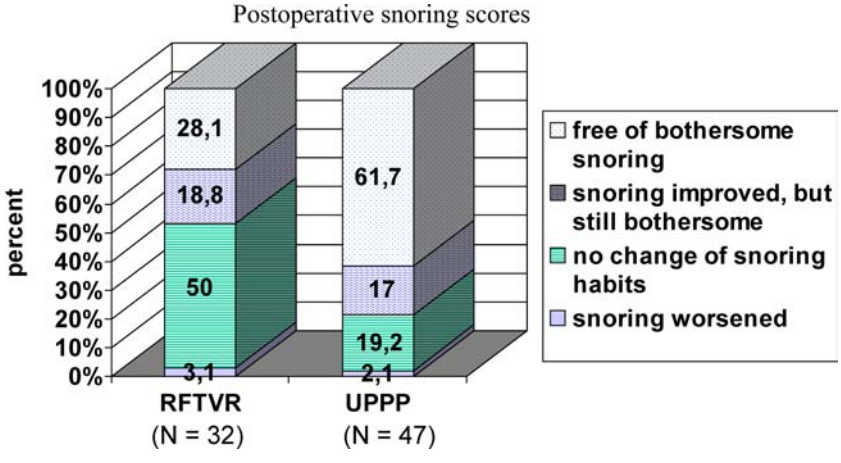

Fig. 2 After RFTVR, 28.1% of the patients were free of bothersome snoring. In 18.1% snoring improved, but was still bothersome, in 50% snoring habits did not change, and in 3.1% they deteriorated. After UPPP 61.7% of the patients were free of bothersome snoring; in 17% snoring improved, but was still bothersome; in 19.2% snoring scores did not change, and in 2.1% they deteriorated

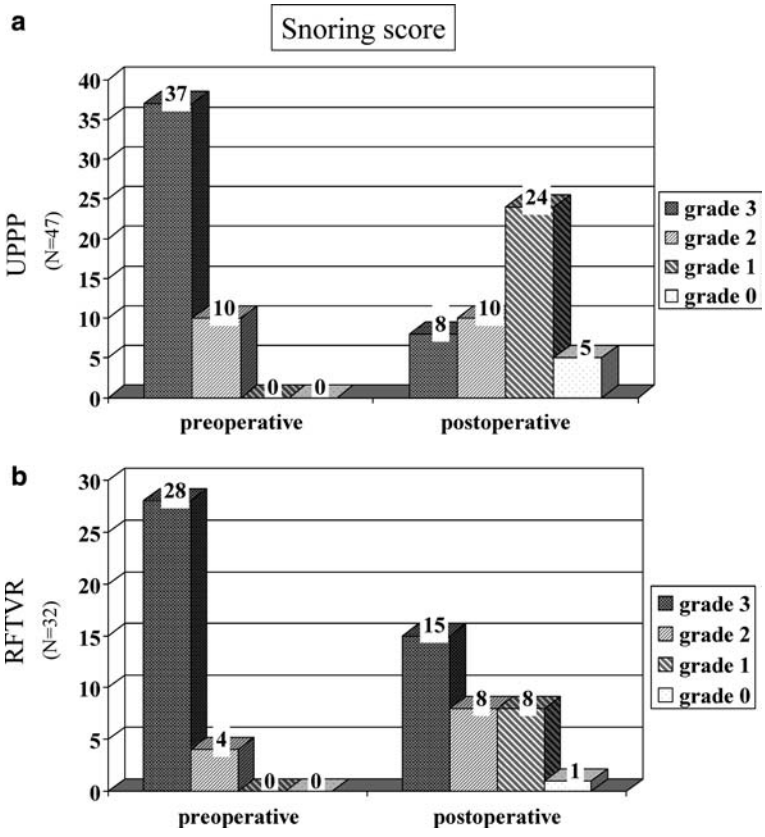

Fig. 3 a After UPPP the number of grade 3 snorers was reduced from 37 to 8. **b** After RFTVR the number of grade 3 snorers was reduced from 28 to 15

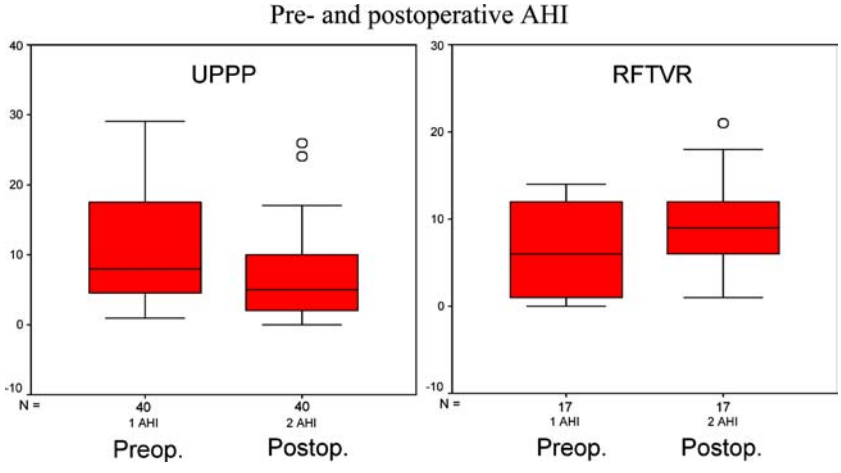

Fig. 4 In the UPPP group the median AHI was reduced statistically significant ($P = 0.025$) from 8.00 (range 1–29) to 5.00 (range 0–26). After RFTVR the median AHI changed from 6.00 (range 0–14) to 9.00 (1–21), which was not statistically significant

polysomnography follow-up found statistically significant improvement of AHI and HI in the UPPP group, but no statistically significant change in the RFTVR group. Preoperatively, an AHI ≤ 10 was measured in 23 of the RFTVR patients (71.9%) and in 26 of the UPPP patients (55.3%). Therefore, a reduction of these higher preoperative values was more likely after UPPP than after RFTVR in this study. The mean AHI of 6 before RFTVR is almost in the range of the normal population (AHI < 5). Therefore, a significant reduction of this value after RFTVR could not be expected. The postoperative rise to a mean AHI of 9 was statistically not significant. In our opinion, this change lies in a range of no clinical relevance because subjectively only one patient complained of increased snoring.

The mean duration of postoperative pain was shorter after RFTVR (median 3 days) compared to UPPP (median 10 days). But one has to keep in mind that the RFTVR treatment has to be repeated up to three times and therefore the days of postoperative pain cumulate. Mild postoperative pain after RFTVR was easily controlled with oral diclofenac for 1–3 days. During hospitalization after UPPP, the patients received i.v. diclofenac and oral tramadol on demand. After discharge analgesic therapy was switched to oral diclofenac.

Table 3 Pre- and postoperative data of 40 patients undergoing UPPP and 17 patients treated with RFTVR who completed postoperative polysomnography follow-up. In the UPPP group AHI and HI improved statistically significantly ($P = 0.025$, $P = 0.034$); other parameters showed no statistically significant change

	UPPP			RFTVR		
	$n = 40$			$n = 17$		
	Preoperative	Postoperative		Preoperative	Postoperative	
AHI (median, range)	8.00 (1–29)	5.00 (0–26)	$P = 0.025$	6.0 (0–14)	9.0 (1–21)	$P = 0.236$
AI (median, range)	2.00 (0–16)	1.00 (0–19)	$P = 0.106$	1.5 (0–4)	2.0 (0–10)	$P = 0.503$
HI (median, range)	5.00 (0–18)	4.00 (0–12)	$P = 0.034$	3.00 (0–11)	6.5 (1–16)	$P = 0.180$
Lowest oxygen saturation (mean, SD)	71.11% ± 12.873	71.47 ± 14.343	$P = 0.795$	75.76% ± 15.458	74.24% ± 13.456	$P = 0.758$
Mean minimal oxygen saturation (mean, SD)	86.43 ± 5.500	88.03 ± 3.079	$P = 0.391$	90.42% (± 2.021)	88.58% ± 4.481	$P = 0.287$

Superficial erosions of the mucosa occurred in 15% of the patients treated with RFTVR. After UPPP, 8.5% of the patients complained of foreign body sensations in the soft palate region and one patient had difficulty swallowing tablets 2 months postoperatively. No case of velopharyngeal insufficiency with regurgitation was observed. With our technique, we strictly preserved the palatoglossal and palatopharyngeal muscles and the base of the uvula including the uvula muscle. Obviously with this muscle-preserving technique long-term sequelae could be prevented.

Previous authors who selected patients with primary snoring for RFTVR of the soft palate reported successful reduction of snoring in 45 to 66.7% [2, 10, 19]. Significant reduction of the RDI was not found [2, 3, 16, 19]. Only Blumen et al. [1] found a 65% success rate in patients with mild OSAS and a significant reduction of the RDI after RFTVR.

The presented study found relatively low success rates after RFTVR exclusively of the soft palate compared to UPPP. One possible reason is that the patients were not randomized, but were clinically selected for one treatment option. Patients presenting more excessive tissue in the region of the soft palate and tonsils underwent UPPP. The higher amount of preoperative "pathology" in the upper airway in the UPPP group is a possible reason for the better outcome in this group.

UPPP was shown to be more efficient, but is more invasive, and the risk of complications, such as bleeding after tonsillectomy and velopharyngeal insufficiency, was reported in the literature. A recently published study on RFTVR of the soft palate and base of the tongue for OSAS patients reported good results compared to CPAP therapy and placebo [20]. Also, multilevel RFTVR of the soft palate, tonsils and base of the tongue showed promising results in 60% of the OSAS patients [3]. This combined treatment of different sites might increase the efficiency of RFTVR in the future, but studies on large patient cohorts are not yet available.

Conclusion

RFTVR is a minimally invasive technique with a short duration of pain and minimal side effects, but the success rate is clearly lower compared to the more invasive UPPP technique. Due to the minimally invasive character of RFTVR, this technique is suitable as the first-step treatment for snoring, but patients should be counseled about possible success rates and different treatment options.

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