Eur Arch Otorhinolaryngol (2008) 265:1361–1365
DOI 10.1007/s00405-008-0640-x

LARYNGOLOGY

UPPP combined with radiofrequency thermotherapy of the tongue base for the treatment of obstructive sleep apnea syndrome

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Received: 14 August 2007 / Accepted: 28 February 2008 / Published online: 18 March 2008

Abstract We investigated the outcome of uvulopalatopharyngoplasty (UPPP) combined with radiofrequency thermotherapy of the tongue base (RFTB) in patients with obstructive sleep apnea syndrome (OSAS) with both palatal and retroglossal obstruction, and we compared these results with the results of single level surgery (UPPP). A retrospective cohort study was performed in patients with mild to severe OSAS who underwent UPPP with or without RFTB. Seventy-five patients with both palatal and retroglossal obstruction underwent UPPP, 38 patients without RFTB (group 1) and 37 patients with RFTB (group 2). The outcome of the surgery was measured by both objective success (defined as a reduction of AHI >50% and AHI below 20) and subjective improvement. In group 1 the overall success rate was 42%, and in group 2 49%. Other polysomnographic values (AI, DI, mean SaO2) improved after surgery (not significant). No serious adverse events occurred. Surgical treatment of combined palatal and retroglossal obstruction remains a challenge. Adding RFTB to UPPP results in a mild improvement compared to UPPP alone. Although the addition of RFTB to UPPP seems to result in only a limited improvement, there is no major downside to it. RFTB is well tolerated and safe.

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Keywords Obstructive sleep apnea syndrome · Radiofrequency thermotherapy · Tongue base · Uvulopalatopharyngoplasty

Introduction

Uvulopalatopharyngoplasty (UPPP) is still the most frequently used surgical treatment for obstructive sleep apnea syndrome (OSAS). Overall outcomes have been disappointing. Meta-analysis by Sher et al. [1] in 1996 indicated an over-all success rate of only 40.7%. This meta-analysis showed that the success rates of UPPP are related to the level of obstruction: an objective success rate of 52.3% in patients with only palatal narrowing or collapse, versus 5.3% in patients with a retroglossal obstruction with or without a palatal component.

Improvements in success rates of UPPP are therefore directly related to patient selection and, to a lesser extent, to modifications of UPPP in selected patients. For instance, Friedman et al. [2] have shown that in patients with palatal obstruction, who previously have had a tonsillectomy, it might be better to perform Z-palatoplasty (ZPP). Patients with only retroglossal obstruction should not undergo UPPP at all.

An important category is formed by patients with combined palatal and retroglossal obstruction. Two often-used systems for determination of the level(s) of obstruction are the Modified Mallampati/Friedman system and sleep endoscopy. We have previously shown that our results of UPPP after patients selection with sedated endoscopy are better than average, with success rates of 70–80%, depending on the definition used [3]. Negative predictors of outcome were: combined palatal and retroglossal obstruction and earlier tonsillectomy [4]. In this period we neither used radiofrequency thermotherapy of the tongue base (RFTB),

nor hyoid suspension (HS), nor ZPP. Since this report we changed our policy. Post tonsillectomy patients now usually will have Z-palatoplasty. Patients with combined palatal and retroglossal obstruction undergo UPPP (or a modification of it) combined with RFTB with or without HS [5]. In general, in case of mild to moderate OSAS, and palatal and partial retroglossal obstruction as assessed by sedated endoscopy, we combine UPPP and RFTB. Although this approach seems logical, little has been published about results of UPPP with RFTB.

RFTB as only the treatment has been proved to be safe, effective, well tolerated and technically simple to perform [6–9]. These advantages make RFTB preferable to use in a multilevel approach together with UPPP, rather than more invasive procedures with a greater risk of complications and morbidity, such as mandibular osteotomy with genioglossus advancement, partial midline tongue resection and hyoid suspension. These operative techniques are preferred in more outspoken, total or subtotal, retroglossal obstruction. Therefore only in case of moderate to severe OSAS, palatal obstruction and total retroglossal obstruction as assessed by sedated endoscopy, we presently combine UPPP, HS and RFTB, the so-called multilevel surgery [10].

In this study, we investigate the value of radiofrequency thermotherapy of the tongue base (RFTB) added to uvulopalatopharyngoplasty (UPPP) in patients with both palatal and retroglossal obstruction. Secondly, we investigate whether this combination of UPPP and RFTB is safe and well tolerated.

Patients and methods

Patients

We performed a retrospective cohort study. All the patients with mild to severe OSAS with both palatal and retroglossal obstruction, who underwent UPPP with or without RFTB in the period from November 2003 until October 2006 in our clinic, were included. Exclusion criteria were an apnea/hypopnea index (AHI) under 5 or over 50 and a medical history with previous UPPP or RFTB or radiofrequency thermotherapy of the palate.

The study population was divided into two groups. In both the groups all the patients had obstruction at palatal and retroglossal level. Group 1 consisted of patients who underwent UPPP alone. Group 2 consisted of patients undergoing multilevel surgery, UPPP combined with RFTB.

Polysomnography

All the patients underwent a preoperative all-night attended comprehensive sleep study using a digital Embla recorder (Flaga Medical devices, Reykjavik, Iceland). Polysomnography (PSG) consisted of electroencephalogram, submental electromyogram and electrooculogram to record the sleep pattern. Pulse oximetry was used to monitor oxygen saturation (SaO_2) and heart rate. Thoracic and abdominal efforts were registered as well as movements of the limbs. Furthermore, nasal airflow and snoring were measured by a pressure sensor.

Obstructive apneas were defined as cessation of airflow for at least 10 s. Hypopneas were defined as periods of reduction of >30% oronasal airflow for at least 10 s. The apnea/hypopnea index (AHI) was calculated as the sum of total events (apneas and hypopneas) per hour of sleep; mild OSAS defined as an AHI $\geq$5, <15, moderate OSAS as an AHI $\geq$15, <30, and severe OSAS as an AHI $\geq$30. The desaturation index (DI) was defined as the mean number of desaturations of >4% per hour.

Sleep endoscopy

Sleep endoscopy during sedation with midazolam or propofol was performed in all the patients to identify the level(s) of obstruction. Patients were assumed having single level obstruction at palatal or retroglossal level, or having obstruction at both palatal and retroglossal level. Obstruction at retroglossal level was divided in partial and complete obstruction.

Surgical techniques

Uvulopalatopharyngoplasty

Uvulopalatopharyngoplasty (UPPP) was carried out according to Fujita's technique. The anterior and posterior tonsillar pillars were trimmed and reoriented and the uvula was excised [11].

A tonsillectomy was performed if tonsils were present [in 64 of 75 patients (85 %)].

Radiofrequency thermotherapy of the tongue base

In the patients in group 2, UPPP was followed by (bipolar) radiofrequency ablation of the tongue base (Celon®) to accomplish stiffening and volume reduction of the tongue base. Energy was delivered with an exclusive needle device through the dorsal surface of the tongue on six sites; each site was treated with a power setting of 7 W, which equals ±42 J (total ±252 J). All the patients received postoperative antibiotics. Two patients received additional RFTB under local anesthesia as secondary procedure.

Postoperative evaluation

Surgical success rate was defined as more than 50% reduction of the AHI and AHI below 20. Response rate was defined as reduction of AHI between 20 and 50%.

When a postoperative PSG was not performed, success and response were based on patient's (and/or partner's) opinion regarding the subjective changes of symptoms after treatment. Subjective success was defined as disappearance of snoring and daytime hypersomnolence and response as decrease of snoring and daytime hypersomnolence. It is clinical reality that diagnostic tests, like postoperative PSG, are not performed when treatment seems satisfactory for patient, doctor or both.

Adverse events

Incidents which might have had a negative effect on the surgical outcome were registered. These incidents were classified into four grades of severity. Grade I was an adverse event that resolved if left untreated or required a simple bedside procedure. Grade II was a minor complication that required an additional intervention that involved a risk of its own, but was eventually resolved. Grade III was a major complication that was associated with a residual or a lasting disability. Grade IV was any complication that resulted in death [12].

Statistical analysis

T test, Fisher's exact test, and chi-square test were employed to evaluate differences between the two patient groups. The *t* test was used to compare preoperative with postoperative mean values. The Cochran–Armitage Trend test was used to compare success rates.

Results

Baseline

The charts of 75 patients with multilevel obstruction, an AHI ≥5 and <50 and no previous OSAS surgery were studied retrospectively. Thirty-eight patients were treated with UPPP (group 1) and 37 patients were treated with UPPP and RFTB (group 2). Patient characteristics are shown in Table 1, including age, gender, body mass index (BMI), AHI, AI, DI, mean SaO_2, and whether or not a tonsillectomy was performed. There were no significant differences between the two treatment groups.

Efficacy

Success and response rates are shown in Tables 2 and 3. The group treated with only UPPP (group 1) had an overall success rate of 42%, this rate increased to 49% in the group treated with both UPPP and RFTB (group 2). This difference was not significant ($P = 0.88$, Table 2). The success and response rates for the patients treated with UPPP with a tonsillectomy were slightly better than the success and response rates for patients treated with UPPP without tonsillectomy but not significant (Table 3).

Pre- and post-operative values are presented in Table 4. All the polysomnographic variables improved after surgery, although not significant. None of the baseline characteristics could be correlated with predicting the postoperative results.

Table 1 Baseline

	Palatal and retroglossal obstruction treated with UPPP Group 1, $N = 38$ (51%)	Palatal and retroglossal obstruction treated with UPPP and RFTB Group 2, $N = 37$ (49%)
Age	45 (25–67)	49 (29–72)
Gender (male)	35 (92%)	30 (81%)
BMI	26.7 (20.9–32.3)	26.4 (21.8–39.0)
AHI	18.9 (5.4–47)	17.8 (5–42.6)
AI	6.8 (0.3–23)	7.8 (0–36.7)
DI	6.4 (0–20.2)	7.7 (0–41)
Mean SaO_2	95.8 (92–98)	95.3 (91–97.3)
Tonsillectomy	35 (92%)	29 (78%)

Mean patient characteristics of 38 patients with palatal and retroglossal obstruction treated with UPPP and 37 patients with palatal and retroglossal obstruction treated with UPPP and RFTB

Table 2 Success and response rates

		Palatal and retroglossal obstruction treated with UPPP Group 1, $N = 38$ (51%)	Palatal and retroglossal obstruction treated with UPPP and RFTB Group 2, $N = 37$ (49%)
Success	Overall	16 (42%)	18 (49%)
	Objective	13 (34%)	14 (38%)
	Subjective	3 (8%)	4 (11%)
Response	Overall	11 (29%)	7 (19%)
	Objective	9 (24%)	6 (16%)
	Subjective	2 (5%)	1 (3%)

Comparison of overall, objective and subjective success and response rates in patients with palatal and retroglossal obstruction treated with either UPPP or UPPP and RFTB

Adverse events

Only a few adverse events occurred. Most were mild and resolved spontaneously or with a simple treatment,

Table 3 Success and response rates with or without tonsillectomy

	Palatal and retroglossal obstruction treated with UPPP Group 1, $N = 38$ (51%)		Palatal and retroglossal obstruction treated with UPPP and RFTB Group 2, $N = 37$ (49%)	
	With tonsillectomy $N = 35$ (92%)	Without tonsillectomy $N = 3$ (8%)	With tonsillectomy $N = 29$ (78%)	Without tonsillectomy $N = 8$ (22%)
Overall success	15 (43%)	1 (33%)	15 (52%)	3 (38%)
Overall Response	11 (31%)	–	4 (14%)	3 (38%)

Comparison of overall success and response rate in patients with palatal and retroglossal obstruction treated with either UPPP or UPPP and RFTB, with or without tonsillectomy

Table 4 Pre- and postoperative values

		Palatal and retroglossal obstruction treated with UPPP Group 1, $N = 38$ (51%)	Palatal and retroglossal obstruction treated with UPPP and RFTB Group 2, $N = 37$ (49%)
BMI	Pre	26.7 ± 2.6	26.4 ± 3.2
	Post	27.0 ± 2.8	25.6 ± 2.1
AHI	Pre	18.9 ± 9.6	17.8 ± 10.3
	Post	12.0 ± 9.0	11.2 ± 10.8
AI	Pre	6.8 ± 5.4	7.8 ± 8.8
	Post	3.9 ± 4.5	4.9 ± 7.5
DI	Pre	6.4 ± 5.5	7.6 ± 8.9
	Post	3.0 ± 3.0	4.3 ± 5.9
Mean SaO_2	Pre	95.8 ± 1.4	95.3 ± 1.4
	Post	96.0 ± 1.1	95.7 ± 1.3

Comparison of pre- and post-operative polysomnographic data in 75 patients with palatal and retroglossal obstruction treated with either UPPP or UPPP and RFTB

grade I/II. After RFTB two patients experienced transient tongue deviation and loss of sensibility, one patient developed a fair amount of edema of the tongue, all resolving without treatment. No major complications, grade II/III, like tongue base abscess, paresis or paralysis, or airway obstruction, occurred.

No major complications, secondary to UPPP, were reported. Four patients had a postoperative hemorrhage, necessitating cauterization (grade II). Temporary postoperative palatal insufficiency was reported in 7 patients and resolved spontaneously in time.

Additional RFTB

In only two patients an extra treatment of the tongue base with radiofrequency thermotherapy followed the initial treatment of UPPP with RFTB. These two patients were both responders.

Discussion

This study shows that adding RFTB to UPPP as treatment for patients with both palatal as retroglossal obstruction leads to a slight, but not significant, improvement in outcome. In our study the overall success rate increased with 7%, from 42 to 49%, by adding RFTB. Based on our experience, we expected that adding RFTB to UPPP would give a small but notable improvement. Nelson found an objective success rate of 50% in his patient group ($N = 13$) with combined palatal and retroglossal obstruction treated with both UPPP and RFTB. He compared these patients with patients with single level palatal obstruction treated with UPPP; their success rate was 57%. Unfortunately in these small series, a group with multilevel obstruction but single level treatment was not studied [13].

The value of adding RFTB to UPPP in patients with multilevel obstruction was also confirmed by others [14–16]. Friedman et al. [14] staged their patients with the Friedman staging system. Adding RFTB to UPPP gave an increase in objective success rate of 13.2%, from 37.9 to 51.1% for Friedman stage II patients, in whom the uvula but not the tonsils could be visualized during inspection of the oral cavity, and an increase of 24.9%, from 8.1 to 33.0% for stage III patients, in whom the soft palate but not the uvula could be visualized. The subjective success rates were higher; 95.9% for stage II patients and 84.1% for stage III patients. Jacobowitz [16] indicated objective success rates of 61% in Friedman stage II patients, and even 89% in stage III patients. Both studies confirm the additional value of RFTB next to UPPP, but are not completely comparable with our and Nelson's study. Friedman et al. [15] used their staging system, suggesting that patients with Friedman stages II and III had obstruction at retroglossal level. Sleep endoscopy to objectify the presence and degree of retroglossal obstruction was not performed. We prefer an extended diagnostic workup, including Friedman staging, polysomnography and sleep endoscopy to objectify the levels of obstruction [3]. In the study of Jacobowitz the

success rates are high, but based on a very small population ($N = 5$ for UPPP + RFTB).

In this study, we found that success rates were slightly better in the patient group treated with UPPP including tonsillectomy. For the patients in which this treatment was not followed by RFTB the success rate improved from 33 without tonsillectomy to 43% with tonsillectomy (group 1). For the patients who also underwent RFTB the success rate changed even more from 38 without tonsillectomy to 52% with tonsillectomy (group 2). This confirms our earlier findings and of others about the negative effect of previous tonsillectomy on the results of OSAS surgery [2, 4].

It was already reported in other studies that RFTB is a minimal invasive, safe procedure [6, 8, 13, 14, 16]. We also found that RFTB added to UPPP is technically straightforward, easy to perform, safe, and well tolerated. The addition of RFTB to UPPP did not lead to serious adverse events, like tongue base abscess or airway obstruction. Stuck et al. [17] advise 600 J at 85°C as optimal energy level leading to optimal lesion size with minimal side effects. In our clinic a total of 252 J is delivered to the tongue base per session. This lower energy level might lead to fewer complications, but will also lead to less volume reduction and thereby minimizing the effect of RFTB. Because we are aware of this, we always advise patients to undergo an additional RFTB-treatment. This study shows that this was only done in a few cases.

Beside this limitation, our study has some other limitations. It is a retrospective cohort study with a small patient group. The slight increase of 42–49% success is as expected, but to make this improvement statistically significant, much more patients would be needed.

To receive more information whether or not adding RFTB to UPPP is successful in multilevel obstructed, both palatal as retroglossal, patients with mild to moderate OSAS, more research will be necessary. Ideally this would be a prospective, randomized trial, with larger treatment groups, including an optimal additional treatment of RFTB.

Conclusion

Surgical treatment of combined palatal and retroglossal obstruction remains a challenge. Adding RFTB to UPPP, results in mild improvement in patients with mild to severe OSAS.

Although its efficacy is low, the approach appears to be well tolerated and safe.

References

1. Sher AE, Schechtman KB, Piccirillo JF (1996) The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. Sleep 19:156–177
2. Friedman M, Ibrahim HZ, Vidyasagar R, Pomeranz J, Joseph NJ (2004) Z-palatoplasty (ZPP): a technique for patients without tonsils. Otolaryngol Head Neck Surg 131:89–100
3. Hessel NS, de Vries N (2003) Results of uvulopalatopharyngoplasty after diagnostic workup with polysomnography and sleep endoscopy: a report of 136 snoring patients. Eur Arch Otorhinolaryngol 260:91–95
4. Hessel NS, Vries N (2004) Increase of the apnoea-hypopnoea index after uvulopalatopharyngoplasty: analysis of failure. Clin Otolaryngol Allied Sci 29:682–685
5. den Herder C, van Tinteren H, de Vries N (2005) Hyoidthyroidpexia: a surgical treatment for sleep apnea syndrome. Laryngoscope 115:740–745
6. den Herder C, Kox D, van Tinteren H, de Vries N (2006) Bipolar radiofrequency induced thermotherapy of the tongue base: its complications, acceptance and effectiveness under local anesthesia. Eur Arch Otorhinolaryngol 263:1031–1040
7. Powell NB, Riley RW, Guilleminault C (2003) Radiofrequency tongue base reduction in sleep-disordered breathing: a pilot study. Otolaryngol Head Neck Surg 120:656–664
8. Riley RW, Powell NB, Li KK, Weaver EM, Guilleminault C (2003) An adjunctive method of radiofrequency volumetric tissue reduction of the tongue for OSAS. Otolaryngol Head Neck Surg 129:37–42
9. Woodson BT, Nelson L, Mickelson S, Huntley T, Sher A (2001) A multi-institutional study of radiofrequency volumetric tissue reduction for OSAS. Otolaryngol Head Neck Surg 125:303–311
10. Richard W, Kox D, den Herder C, van Tinteren H, de Vries N (2007) One stage multilevel surgery (uvulopalatopharyngoplasty, hyoid suspension, radiofrequent ablation of the tongue base with/without genioglossus advancement), in obstructive sleep apnea syndrome. Eur Arch Otorhinolaryngol 264:439–444
11. Fujita S, Conway W, Zorick F, Roth T (1981) Surgical correction of anatomic abnormalities in obstructive sleep apnea syndrome: uvulopalatopharyngoplasty. Otolaryngol Head Neck Surg 89:923–934
12. Rombout J, de Vries N (2001) Complications in sinus surgery and new classification proposal. Am J Rhinol 15:363–370
13. Nelson LM (2001) Combined temperature-controlled radiofrequency tongue reduction and UPPP in apnea surgery. Ear Nose Throat J 80:640–644
14. Friedman M, Ibrahim H, Lee G, Joseph NJ (2003) Combined uvulopalatopharyngoplasty and radiofrequency tongue base reduction for treatment of obstructive sleep apnea/hypopnea syndrome. Otolaryngol Head Neck Surg 129:611–621
15. Friedman M, Ibrahim H, Joseph NJ (2004) Staging of obstructive sleep apnea/hypopnea syndrome: a guide to appropriate treatment. Laryngoscope 114:454–459
16. Jacobowitz O (2006) Palatal and tongue base surgery for surgical treatment of obstructive sleep apnea: a prospective study. Otolaryngol Head Neck Surg 135:258–264
17. Stuck BA, Köpke J, Maurer JT, Verse T, Eckert A, Bran G, Duber C, Hormann K (2003) Lesion formation in radiofrequency surgery of the tongue base. Laryngoscope 113:1572–1576