THE MAGNETIC RESONANCE EVALUATION OF REDUCTION IN VOLUME OF THE TONGUE BASE AFTER BIPOLAR RADIOFREQUENCY INDUCED THERMAL ABLATION IN ADULTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME: PRELIMINARY RESULTS

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ABSTRACT

Objective: *Obstructive sleep apnea syndrome (OSAS) is a complex disease involving multiple structures of the upper airway system. In our study we sought to evaluate the effect of bipolar radiofrequency induced thermo ablation on the volume of the tongue base using pre and post-procedure MRI scans.*

Material and Method: *12 patients that applied to our clinic with OSAS during March 2009-October 2009 were included in our study. Patients underwent pre-operative MRI and post-operative MRI 7 weeks after surgery. Outcomes included Epworth sleepiness scale and the modified Mallampati scale. 7 watt bipolar radiofrequency was applied to each patient's tongue base at 5-7 different locations for 45-55 sec resulting in energy application in a range of 315-385 joule.*

Results: *After 1 session of radiofrequency ablation, MRI scans performed 7 weeks after surgery showed a 6.05% decrease in tongue base volume. An 8.51% increase in distance between the tongue base and posterior pharyngeal wall was also noted in our study. The Epworth sleepiness scale performed before and after surgery showed a pronounced decrease in patient symptoms. Visual analog scales used for the determination of pain and dysphagia showed a steady decrease in both symptoms from day 1. Pre-operative antibiotic prophylaxis with 2 gr of cefazoline was administered and no infections or other complications were observed.*

Conclusion: *Bipolar induced thermoablation significantly decreases the size and bulk of the tongue base observed on MRI scans and lessens patient complaints after only 1 session.*

Key Words: *Obstructive sleep apnea syndrome, magnetic resonance imaging, complications, snoring* ***Nobel Med 2012; 8(1): 95-99***

OBSTRÜKTİF UYKU APNESİ OLAN YETİŞKİN HASTALARDA, BİPOLAR RADYOFREKANS TERMAL ABLASYONU SONRASI DİL KÖKÜ HACMİNDE OLUŞAN KÜÇÜLMENİN MANYETİK REZONANS İLE DEĞERLENDİRİLMESİ: ÖN BULGULAR

ÖZET

Amaç: Obstrüktif uyku apnesi sendromu (OSAS) üst solunum yollarının bir çok seviyesini kapsayan kompleks bir patolojidir. Biz çalışmamızda bipolar radyofrekans termoablasyonun dil kökü hacminde oluşturduğu küçülmeyi pre ve post-operatif MR görüntülemesiyle göstermeyi amaçladık.

Materyal ve Metod: Mart 2009-Ekim 2009 tarihleri arasında kliniğimize OSAS şikayeti ile başvuran 12 hasta çalışmaya alındı. Hastaların Epworth uyuklama skalası ve mallampati skorları belirlendi. Hastalara preoperatif ve ameliyat sonrası 7. haftada MR görüntülemesi yapıldı. Hastaların dil köküne 5-7 ayrı lokalizasyonda 7 wattlık bipolar radyofrekans cihazıyla 44-55 saniye boyunca toplam 315-385 joule enerji uygulandı.

Bulgular: Bir seans radyofrekans uygulandıktan sonra hastaların 7 hafta sonra çekilen MR görüntülemelerinde dil kökünde ortalama %6.05'lik küçülme saptandı. Dil kökü ile posterior farengeal duvar arasındaki mesafede ortalama %8.51 artış saptandı. Hastaların pre- ve post-operatif Epworth skala skorlarında önemli bir düşüş saptandı. Ağrı ve yutkunmada oluşan ağrıyı değerlendirmek için uygulanan vizüel analog skalada her iki semptomun da 1. günden sonra azaldığı saptandı. Pre-operatif profilaksi olarak 2gr sefazolin uygulanan hastaların hiç birinde komplikasyon gelişmedi.

Sonuç: Bipolar radyofrekans ile dil köküne termoablasyon uygulanması dil kökünde MR görüntülemesi ile de görülebilen anlamlı şekilde küçülme oluşturmaktadır ve hastaların şikayetlerinde 1. seansdan sonra azalmaya neden olmaktadır.

Anahtar Kelimeler: Tıkayıcı uyku apne sendromu, manyetik rezonans görüntüleme, komplikasyon, horlama **Nobel Med 2012; 8(1): 95-99**

INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) is a complex pathology involving the upper respiratory tract that leads to a variety of systemic problems including hypertension, impotence and depression.[1-2] The prevalence of OSAS in middle aged adults is 24% for males and 9% for females in the general population.[3] Epidemiologic evaluation of the disease shows that obesity is the most significant predictor followed by age of the patient, male gender and ethnicity.[4] Even though the gold standard treatment for OSAS is continuous positive airway pressure (CPAP) application many patients are non-compliant to the treatment and one study showed that most patients use the device less than the half of the recommended sleep time.[5] The use of radiofrequency induced thermo ablation was first introduced in 1998 as minimally invasive, safe and effective technique for the reduction of turbinate hypertrophy.[6] This technique is increasingly being used in volumetric reduction of the tongue base for OSAS patients. A pilot study investigating the feasibility, safety and possible efficacy of this treatment modality when applied to the tongue base concluded that this technique was an effective method of treatment for OSAS.[7] In 2002 Stuck et al. reported the effectiveness of radiofrequency on the tongue base evaluated with the use of pre and post-treatment polysomnographic comparisons.[8] In our study we set out to show the volumetric reduction produced by radiofrequency induced thermo ablation on the tongue base demonstrated by MRI and also to evaluate the effect of treatment using the Epworth sleepiness scale.

MATERIAL and METHOD

Our study was a prospective study and involved 12 patients that applied to our Ear, Nose and Throat clinic with complaints of snoring, daytime sleepiness and awakenings during the night, in the period of March 2009-October 2009. Patients were examined upon arrival and only patients with a modified Mallampati score of 3-4 were included in the study. Other criteria included that no patient be hypothyroid and that none of subjects had previously undergone surgery of the tongue base. After endoscopic examination each patient was questioned using the Epworth sleepiness scale for severity of daytime sleepiness which is a cardinal symptom of OSAS. Twelve patients were included in our study and of these 6 (50%) were female and 6 (50%) were male. Patients were aged between 31 and 64 with a mean age of 46.1. Patients were then referred to Yedikule Pulmunology Hospital, Istanbul for polysomnography to diagnose OSAS. Patient demographic properties and polysomnography results are shown in Table 1.

MRI (1.5 Tesla MR, Excite 2.0, GE Medical Systems) of the tongue base immediately prior to surgery and →

7 weeks after the procedure was performed. Analytical procedures regarding the MRI scan included the following; 1. Volumetric analysis of the tongue base where the tongue base borders were, the circumvallate papillae anteriorly, the lingual tonsil posteriorly and the hyoglossal and styloglossal muscles laterally on each side. 2. The tongue and the tongue base dimensions were both measured in the coronal, axial and sagittal plans. 3. Midsagittal evaluation of the oropharyngeal air passage between the tongue base immediately caudal to the tip of the uvula and the posterior pharyngeal wall.

Application of radiofrequency to the tongue base was performed under general anesthesia. After a prophylactic 2 gr cefazoline injection a unique bipolar radiofrequency distributor probe with a diameter of 1.3 mm (CelonProSleep-plus) was used to apply radiofrequency to the tongue. A Celon® radiofrequency generator was used for the delivery of temperature controlled radiofrequency energy. 7 watts of radiofrequency energy was applied with the probe to 5-7 different sites around the circumvallate papillae for 45-55 seconds per site. This accounted for a mean energy application of 315-385 joules for each patient.

Patients were internalized for 1 day post-operatively and post-operative pain and dysphagia were documented using a standard 10 cm visual analog scale (0=no pain/dysphagia, 10=severe pain/dysphagia).

Statistical analyses were conducted using the SPSS version 13. Data comparison was performed using a paired t test and the confidence interval was accepted as 95%. A p value under 0.05 was accepted as statistically significant.

RESULTS

Twelve patients were included in our study. Of these 6 (50%) were male while the other 6 (50%) were female subjects. Age range varied from 31 to 64 with a mean age of 46.1 years. The preoperative tongue base volume was a mean of 28.41 ± 4.26, whereas postoperative volumetric analysis measured 7 weeks after surgery showed the tongue base volume to be 26.79 ± 4.14. There was a 6.05% decrease in tongue base volume which was statistically significant (p=0.001) (Table 2). Pre-operative and post-operative transverse length of the tongue was 45.82±5.57 and 43.5±4.66 respectively (p=0.026) showing a statistically significant reduction in length. All in all the post-operative values showed that there was a major decrease in tongue base volume clearly seen with MRI measurements performed prior to and after surgery. (Figures 1 and 2) The distance between the tongue base and the posterior pharyngeal wall was also considered a parameter in our study and showed statistical significance (p=0.014) with an 8.51% increase in length after surgery.

Epworth sleepiness scale evaluation had a mean of 11.25±3.46 points for pre-operative patients and decreased to 8.5±3.23 in post-operative patients

Table 1: Demographic features and RDI (respiratory distress index), Mallapati scores and epworth sleepiness scales of patients included in the study. (BMI: body mass index, ESS: Epworth Sleepiness Scale)

Patient no	Age	Gender	BMI	RDI	Mallampati	ESS
1	45	M	30.859	69.4/hour	Grade 4	17
2	64	M	25.825	6/hour	Grade 3	4
3	31	F	25.390	17/hour	Grade 3	7
4	41	F	32.421	28/hour	Grade 4	10
5	37	F	29.996	16/hour	Grade 4	15
6	47	F	32.435	6/hour	Grade 3	5
7	50	M	46.225	58/hour	Grade 4	17
8	51	M	29.860	30/hour	Grade 4	10
9	50	F	28.902	15/hour	Grade 3	11
10	48	F	32.446	7/hour	Grade 3	9
11	48	M	29.166	10/hour	Grade 3	7
12	42	M	48.284	90/hour	Grade 4	13

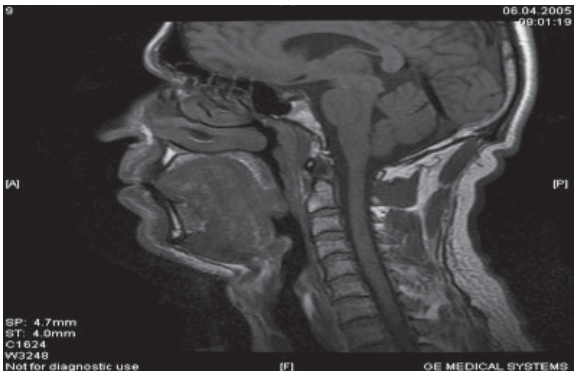

Figure 1. The T1 weighted saggital view of the patient before surgery.

Figure 2. The T1 weighted saggital view of the same patient as in figure 1, 7 weeks after surgery. Note the increase in the distance between the tongue base and posterior pharengeal wall.

Table 2: Comparison of pre-operative and post-operative tongue base volumes in our study group													
Patient no	1	2	3	4	5	6	7	8	9	10	11	12	Paired t-test
Pre-operative tongue base volume	31.3 mm^3	23.4 mm^3	24.7 mm^3	31.2 mm^3	24.4 mm^3	24.6 mm^3	28.7 mm^3	33.2 mm^3	26.5 mm^3	24.7 mm^3	32.1 mm^3	36.2 mm^3	
Post-operative tongue base volume	30.1 mm^3	22.6 mm^3	23.2 mm^3	30.4 mm^3	23.9 mm^3	22 mm^3	27 mm^3	31.9 mm^3	25.6 mm^3	21.5 mm^3	31.3 mm^3	32 mm^3	$p \leq 0.001$

(p=0.001) showing a notable decrease in subjective complaints of our study group.

Post-operative pain and dysphagia evaluation performed by a 10 cm visual analog scale for a 1 week period (1=no pain/dysphagia, 10=intolerable pain/dysphagia) showed a mean of 8.62 for dysphagia and 8.21 for pain on the first day. A steady decrease followed and 7th day mean values were 3.56 for dysphagia and 2.12 for pain.

DISCUSSION

This study aimed to assess the reduction in tongue base volume, evaluated by MRI, created by bipolar radiofrequency induced thermal ablation. Our investigation showed that after only one session of bipolar radiofrequency induced thermal ablation treatment an MRI scan performed seven weeks after surgery showed that there was a significant decrease in tongue base volume together with an increase in the distance between tongue base and posterior pharyngeal wall. Post operative Epworth sleepiness scales also showed a marked decrease of objective symptoms in patients.

OSAS is encountered in approximately 2-5% of the adult population and causes severe neurological and cardiovascular problems as well as cognitive malfunctions, decrease in concentration and impotence.[9] After the acceptance of OSAS as a major pathology many authors have sought to find the most appropriate management of the condition. Hypopharyngeal obstruction is an important factor in OSAS leading to severe upper airway tract obstruction. In the past surgical interventions for hypopharyngeal obstruction including bimaxillary anterior displacement, mandible osteotomies and tongue base suspension have been used and are still being used today with the major disadvantage of being too invasive and having high post-operative morbidity. Today the aim is to find a treatment that is minimally invasive, easy to apply, have a short treatment period and affect patient comfort as minimally as possible. Since 1997 bipolar induced radiofrequency thermal ablation has been used as a minimally invasive volume reducing procedure on the lower conchae, and has been shown to be a safe and effective choice. In 1997 Powell et al. described the use of radiofrequency on porcine tongue base and showed the gross and histological changes created by the procedure. His study confirmed the volume reducing effect of radiofrequency on the tongue base.[10] After this Powell et al. went on to publish a preliminary report of radiofrequency applied to the tongue base of 18 patients with OSAS. MRI imaging used in the study showed a marked decrease in tongue base size and complaints regarding OSAS were significantly reduced.[7] These findings are in correlation with our study where both tongue base volume and patient symptoms were decreased. The major difference in our study being that our study group underwent only one session of radiofrequency treatment whereas patients in the previous study had undergone a mean of 4.6 treatment sessions. We, in no way concur or contend the fact that only one session of radiofrequency is sufficient for appropriate tongue base surgery in patients with OSAS but can comfortably confer that a single session of bipolar radiofrequency results in a marked decrease in tongue base size. Another study designed to evaluate tongue base size was published by Stuck et al. in 2005. Ten patients with sleep respiratory disorders were included in his study and all underwent radiofrequency tissue ablation to the tongue base. Pre-operative and post-operative volume analysis showed no change. There was no significant difference in the length of the tongue, maximum height of the tongue or the retrolingual space. They concluded that radiofrequency showed its affects by preventing the collapse of the upper airway rather than on the anatomy.[11]

In our study 12 patients with a modified mallampati score of 3 or 4 were included. The mean respiratory distress index (RDI) pre-operatively was between 6/hour–69.4/hour. We did not perform polysomnographic evaluation post-operatively as treatment was not completed at the time. Every patient was evaluated for tongue base volume with an MRI scan prior to surgery and the decrease in size was calculated by comparison of the first MRI→

scan to a scan performed 7 weeks after surgery. Most studies regarding radiofrequency application to the tongue base performed to date have used the Somnus unipolar radiofrequency generator. Tatla et al. published a study comparing the Somnus unipolar radiofrequency generator to the Celon bipolar radiofrequency generator in patients with OSAS.[12] Both generators have a similar power outlet and work at similar frequencies. The study showed that application times were much longer in duration for the unipolar generator than the bipolar generator, 120-180 sec and 3-8 sec respectively. It also demonstrated that the amount of energy applied for a single puncture was more than 10 times higher for the Somnus unipolar generator. The fact that the Celon bipolar radiofrequency generator is as its name suggests bipolar, means that it affects the immediate tissue surrounding the tip of the probe. Together with its auto-acoustic feedback mechanism this property allows for safe and effective radiofrequency application which is why we chose to use this particular generator in our study. Each of our subjects underwent a single session of radiofrequency application to the tongue base under general anesthesia. The Celon probe was used to apply the radiofrequency energy to five-seven different sites anterior and posterior to the circumvallate papillae through five to seven different punctures. A total of 315-385 joules of energy was administered resulting in a 6.05% decrease in size of the tongue base and an 8.51% increase in the distance between the tongue base and the posterior pharyngeal wall after 7 weeks. In this pilot study, we concluded that with the employment of bipolar radiofrequency to the tongue base we were able to establish a significant decrease in size in a shorter period of time, with less energy application and with a lower dosage of radiofrequency compared to the unipolar method.

Some of the complications seen after bipolar radiofrequency to the tongue include, mucosal ulceration, infections, bleeding, dysphagia and airway compromise. None are very frequent and the commonest complication is infection of the tongue with or without abscess formation seen in approximately 3.1% of cases.[13] In our study none of the patients presented with complications during the 8 week follow-up period.

Radiofrequency tissue ablation has been successfully exercised in the practice of ENT for over a decade. Though relatively new, bipolar radiofrequency to the tongue base is also an exciting breakthrough in the treatment of hypopharyngeal and retrolingual obstruction in OSAS. The fact that this technique is minimally invasive, easy to apply, shows low morbidity and mortality and requires a short hospital stay promotes it as an important intervention for the treatment of sleep-disordered breathing. We were able to create a significant decrease in the size of the tongue base with only 1 session of bipolar radiofrequency application. Other beneficial results included an increase in the distance between the tongue base and the posterior pharyngeal wall. Epworth sleepiness scale values were also considerably diminished. These preliminary results offer insight on the effectiveness of bipolar radiofrequency on the tongue base and its impact on decreasing the volume of an overly large tongue base. We are continuing our research and will report our long-term results when they become available.

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