

ARAŞTIRMA / RESEARCH ARTICLE

The effect of tissue ablation model with radiofrequency induced thermotherapy and ethanol in tongue base

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Dil kökünde radyofrekans etanol kombinasyonunun doku ablasyonu üzerine etkisi

Amaç: Kobay (guinea pig) dil kökünde bipolar radyofrekans ve etanol kombinasyonunun doku ablasyonu üzerindeki etkisinin değerlendirilmesi.

Yöntem: İlk gruptaki deneklerin dil köküne bipolar radyofrekans ile 14 Watt enerji verildi. İkinci gruptaki deneklerin dil köküne 0.2 ml, %70'lik etanol enjekte edildi ve 3. gruptaki deneklerin dil köküne 0.2 ml, %70'lik etanol enjeksiyonundan 5 dakika sonra bipolar radyofrekans uygulandı. Dil kökü ile damak arası mesafe ölçümleri, manyetik rezonans görüntüleme ile uygulama öncesi ve uygulamadan 6 hafta sonra yapıldı.

Bulgular: Dil köküne bipolar radyofrekans uygulaması, dil köküne etanol enjeksiyonuna göre daha fazla miktarda doku ablasyonu sağlamaktadır. Bu iki yöntemin kombinasyonu dil kökünde geniş nekroz oluşturarak kobayların büyük çoğunluğunun ölmesine neden olmuştur.

Sonuç: Bipolar radyofrekans ve etanol enjeksiyonu kombinasyonunun etkinliğini arttırmak için, doğru etanol miktarı ve doğru miktarda enerjiyi saptamamızı sağlayacak çok sayıda çalışma gereklidir.

Anahtar Sözcükler: Bipolar radyofrekans, etanol, dil kökü ablasyonu, manyetik rezonans görüntüleme, kobay.

Abstract

Objectives: To determine the effect of combination of bipolar radiofrequency induced thermotherapy (RFITT) and ethanol on tissue ablation of guinea pig tongue base.

Methods: To the first group, 14 Watts of energy was delivered to the tongue base using RFITT. For the second group 0.2 ml 70% ethanol was injected into the tongue base, and the third group received RFITT 5 minutes after 0.2 ml 70% ethanol injection to the tongue base. The distances between the tongue base and the palate were evaluated with magnetic resonance imaging pre,-and post-application after 6 weeks.

Results: The utilization of bipolar RFITT on tongue base caused more tissue ablation than ethanol injection into the tongue base. The combination of the two caused extensive necrosis on tongue base and killed the majority of the guinea pigs.

Conclusion: Many studies are needed for adjustment of the correct volume of ethanol and the correct amount of energy for RFITT obtained to increase the efficacy of combination of bipolar RFITT and ethanol.

Key Words: Bipolar radiofrequency, ethanol, tongue base ablation, magnetic resonance imaging, guinea pig.

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Introduction

Obstructive sleep apnea syndrome (OSAS) is associated with cardiovascular disease, a decrease in quality of life and performance deficits, and

motor vehicle accidents and affects 2-4% of adults.^{1,4} Although continuous positive airway pressure (CPAP) remains the gold standard therapy for OSAS, many patients do not prefer the use of this device because of impaired quality of sleep.⁵ Surgical treatment for OSAS is localized to the nose, soft palate, tonsils, hyoid bone, tongue base, thyroid cartilage, mandible, and maxilla.⁶ Temperature-controlled radiofrequency tissue ablation (TCRFTA) has been applied to the tongue base resulting in reduction of tissue volume and has been shown to improve OSAS with minimal morbidity.⁷ TCRFTA to the human tongue was shown to be the most effective use of this technology in improving sleep-disordered breathing.⁸ TCRFTA causes coagulation necrosis leading to fibrosis and tissue contraction.

The bipolar radiofrequency induced thermotherapy (RFITT) has inherent bipolar tip safety.⁹ The bipolar needle has both electrodes and radiofrequency distributes between the electrodes. The radiofrequency is converted into thermal energy by the tissue resistance.^{9,10} The resistance in the tissue changes is measured directly at the bipolar RFITT applicator tip and is continuously recorded and evaluated by power control unit. When the defined impedance threshold is reached in the tissue, the coagulation is automatically ended and no further thermal damage beyond the therapeutic volume occurred.

Ethanol injection was used for many years for ablation of hepatocellular carcinoma.¹¹ In recent years, the restricted ablation effect of ethanol on oral mucosa has been observed.^{12,13} The ablation effects of ethanol and steroid on the elongated uvula and soft palate was examined in OSAS, and was shown to decrease uvula length with improved apnea-hypopnea index.¹³

In our study the effect of the bipolar RFITT, 70% ethanol and a combination of the two on guinea pig tongue base volume was observed using magnetic resonance imaging (MRI) and effect on tissue using histopathologic examination.

Materials and Methods

This study was performed at Şişli Etfal Research and Training Hospital ENT Clinics Experimental Research and Scientific Training Laboratory. The experimental procedure was approved by the Animal Care and Use Committee at Istanbul University, Veterinary Faculty, and the study protocol was approved by the Experimental Ethics Committee of Şişli Etfal Training and Research Hospital. After 12.5 mg/kg xylazine and 65 mg/kg ketamine anesthesia, the guinea pigs were weighted. The weights were between 640 mg and 840 mg (mean, 738 g; standard deviation, 61.1 g). The longest distances from the surface of the tongue base in regard to a line drawn perpendicular to the palate of 24 guinea pigs were measured in sagittal T1 weighted spoiled gradient echo images, and they were randomly divided equally into 3 groups. The GE Advantage Windows Workstation was used for the evaluation of the data. Magnetic resonance images were acquired using GE Signa 1.5 T TwinSpeed Excite (GE Medical Systems, Milwaukee, WI, USA). After a multiplanar localizing sequence, T1 weighted spoiled gradient echo (SPGR) sequence in the sagittal plane and fat-saturated T2 weighted fast spin echo sequence in coronal and sagittal plane were performed. All sequences were performed with a 12x12 cm field of view, a 2 mm slice thickness, a 0.3 mm gap between slices and 2 excitations. T1 weighted spoiled gradient echo sequence was performed with a TR:400 and TE:15. The fat saturated T2-weighted fast spin echo sequence was performed with a TR: 100 and a TE:5000.

For the first group of guinea pigs, 14 watts (W) of energy was delivered to the tongue base around the V-shape (circumvallate papillae) using Celon® bipolar RFITT (CelonLabENT, Celon AG Medical Instruments, Teltow, Germany). The energy was applied for approximately 4 seconds. Celon Probreath was used as a bipolar electrode with a diameter of 1.3 mm. For the second group 0.2 ml 70% ethanol was injected into the tongue base, and the third group received 14 W of RFITT 5 minutes after 0.2 ml 70% ethanol injection to the tongue base. Six weeks later the tongue base of each animal was evaluated using MRI with the same parameters, and after the guinea pigs sacrifice via intracardiac potassium iodide, tongue base biopsies were obtained and histopathological evaluations were undergone.

Results

In the first evaluation of tongue bases, it was determined that some of the tongue bases were in contact with the palates and longest distances were measured between the tongue bases and the palates

in the other animals (Figure 1). In the group that was subjected to tissue ablation using only radiofrequency, 4 guinea pigs tongue bases were in contact with the palates. In other guinea pigs, the longest distances between the tongue base and the palate were measured at a range of 0.4-0.6 mm [an average of 0.25 mm, a standard deviation (std) of 0.27] before the bipolar RFITT application. In the RFITT group after 6 weeks of application, the longest distances between the tongue base and the palate were measured at a range of 2.6-3.3 mm (an average of 2.93 mm, a std of 0.22) (Figure 2). In the second group in which the tongue base was injected with ethanol, the tongue bases of the 3 guinea pigs were in contact with the palates before the ethanol injection. In the remaining guinea pigs, the distances between the tongue base and palate were measured between 0.4-0.6 mm (an average of 0.31 mm, a std of 0.26). After the ethanol injection, the distances were measured between 2-3 mm (an average of 2.5 mm, a std of 0.22) (Figure 3). The difference between RFITT and ethanol groups was shown to have significant statistical difference (Paired Student's t-Test, $p < 0.01$).

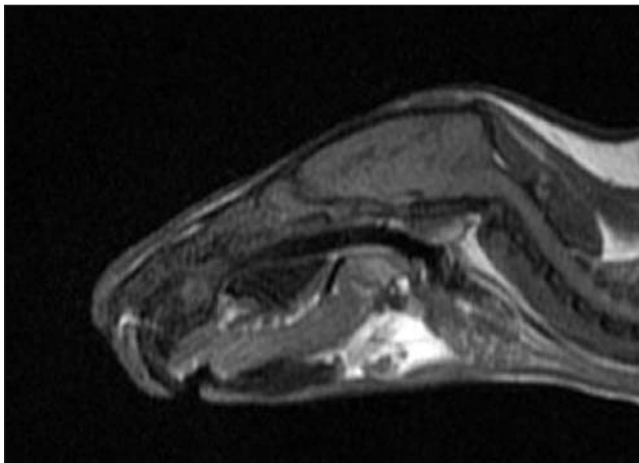


Figure 1. Sagittal view of the tongue base of a guinea pig on MRI. Note the minimal distance between the tongue base and the palate.

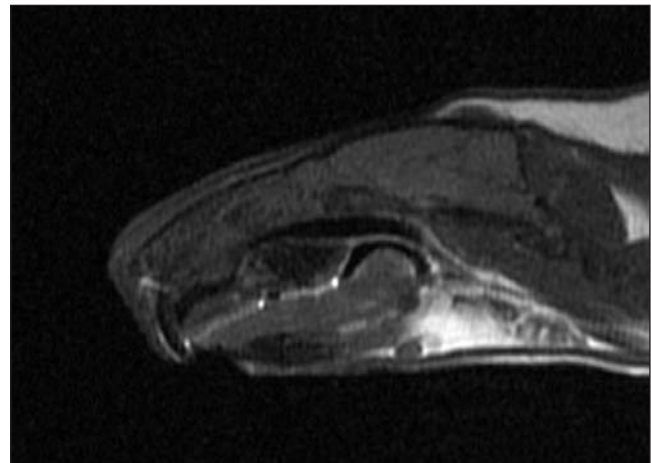


Figure 2. Evaluation of the tongue base of a guinea pig which underwent RFITT after 6 weeks on MRI. Note the increased distance between the tongue base and the palate.

Five out of the 8 guinea pigs which had received bipolar RFITT 5 minutes after 0.2 ml 70% ethanol injection had to be sacrificed due to deterioration of general health. The remaining 3 were shown to have an extensive decrease in tongue base, but with focal necrosis (Figure 4). The macroscopic examinations of the guinea pigs which were sacrificed during the study showed abscess formation and extensive necrosis. The guinea pigs in the same group which were sacrificed on the 6th week showed focal necrosis and an increase of fibroblasts in histopathological evaluation (Figure 5).

Discussion

Radiofrequency induced tissue ablation is used on the soft palate, tonsils, nasal conchae and tongue base in the treatment of OSAS. The effects of radiofrequency surgery on tongue volume had been investigated before and a reduction of mean tongue volume of approximately 17% had been reported. RFITT of the tongue base was introduced as a method to

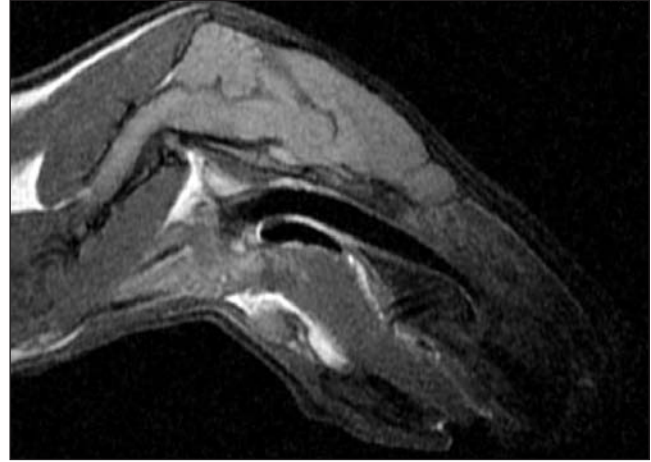


Figure 3. Sagittal section of the tongue base of a guinea pig 6 weeks after ethanol application. The increase in distance between the tongue base and the palate is notable.

decrease retrolingual obstruction in OSAS.⁸ However, studies showed large differences in success rates from center to center. RFITT on tongue base needs 2 to 5 treatment sessions, and a majority of patients received 5 treatment sessions.^{5,14} Additional RFITT treatments add cost, potential patient morbidity, and

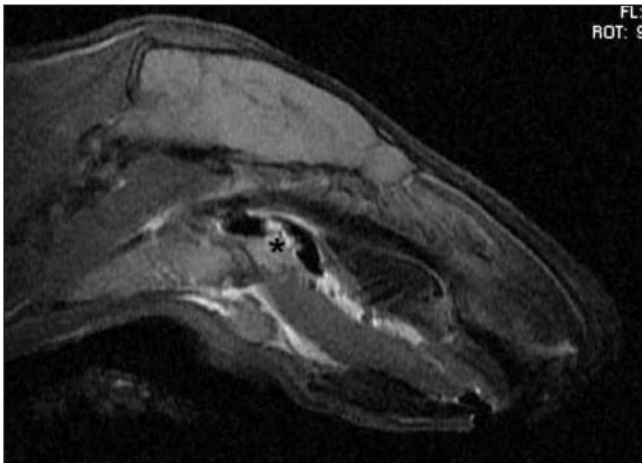


Figure 4. MRI of the tongue base of a guinea pig that had received both RFITT and ethanol injections to the tongue base 6 weeks after treatment. Necrosis and irregularities (*) of the tongue base should be noted.

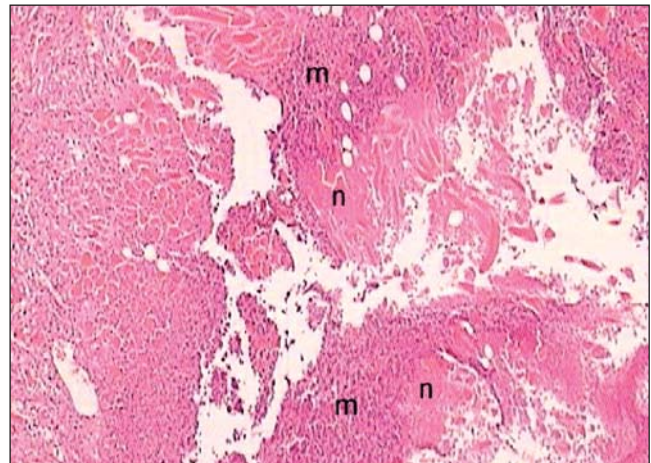


Figure 5. Histopathological evaluation of the tongue base of the guinea pig 6 weeks after RFITT and simultaneous ethanol application shows necrosis (n) and an increase in mononuclear cells (m) (HE x40).

[Color figure can be viewed in the online issue, which is available at www.turkarchotolaryngol.org]

a decrease in patient compliance. The complications of tongue base RFITT include tongue neuralgia, severe edema of the mouth floor, tongue abscess, and hypoglossal nerve paralysis.^{15,16}

Ethanol which has been used for many years for liver tumor ablation has also been used experimentally as a submucosal injection for restricted ablation.^{11,12,17} It has also been shown that a mixture of ethanol/steroid injected into the elongated uvula and soft palate resulted in shortening of the uvula and improvement in snoring.¹³ There is no study that combines the effect of RFITT and ethanol for tongue base volume reduction in literature. The aim of this study was to determine the effects of bipolar RFITT and ethanol on guinea pig tongue base, and to seek a probable increase in the effect of RFITT with ethanol combination.

In this study, Celon® RFITT was used with a bipolar probe. This ensures that only tissue in the immediate vicinity of the probe tip, which has a bipolar arrangement of electrodes in the needle, is exposed to the radio-frequency current. This provides shorter application time (3-8 sec) and less energy per puncture (50-70 J).⁹ This unit provides safety by acoustic feedback and auto-stop power control to eliminate the risk of burns. The reason we used the Probreath applicator which is normally used for turbinate hypertrophy reduction in human beings is that its radius is appropriate for guinea pig tongue base. The applicator Prosleep plus, normally used for tongue base reduction in human beings has a larger diameter and is not appropriate for the guinea pig.

Volumetric evaluation of the guinea pig tongue base was not able to be initiated due to problems involving standardization of volume values. Due to the fact that the size of the guinea pig tongue base is small and its relationship to surrounding structures is not well defined in MRI, small miscalculations may

lead to big mistakes when 3D volumetric evaluation is performed. This is why we measured the distance between the palate and tongue base with a perpendicular line drawn from the surface of the tongue base and used this value as a reference in our study.

Combined radiofrequency and alcohol injection for percutaneous hepatic tumor ablation provided larger volume of ablation and necrosis.¹⁸ The important disadvantage of RFITT on tongue base is majority of patients receive many treatment sessions.^{6,5,14} In our study we showed the combination of bipolar RFITT with ethanol injections enhanced the amount of tissue ablation and thus created a larger decrease in tongue base volume. In a previous study injections of various concentrations of ethanol to the tongue base were compared and a 70% concentration of ethanol was observed to show the greatest amount of contraction with best results regarding healing.¹² Analysis showed that bipolar RFITT when used alone created a larger amount of tissue ablation in tongue base volume when compared to the group of studies injected with ethanol, whereas the combination of bipolar RFITT with ethanol caused necrosis instead of tissue ablation. During follow-up, 5 out of the 8 guinea pigs had to be sacrificed due to deterioration in general health. Postmortem histopathologic evaluation demonstrated abscess and wide spread necrosis of the tongue base. The remaining 3 guinea pigs were evaluated 6 weeks after with MRI which showed more tissue ablation and limited necrosis observed histopathologically. Some of the reasons that lead to such catastrophic results resulting from this combination could be; the incorrect amount of RFITT energy application after ethanol injection, the incompatibility of the radiofrequency device bipolar electrode (a diameter of 1.3 mm) to the guinea pig tongue base muscle volume and the general properties (flaccid) of the tongue base muscle.

Conclusion

The utilization of bipolar RFITT on tongue base caused more tissue ablation than ethanol injection into the tongue base. The combination of the two caused extensive necrosis on tongue base and killed the majority of the guinea pigs. Many studies are needed for adjustment of the correct volume of ethanol and the correct amount of energy for RFITT obtained for decreasing the number of treatment sessions and to increase the efficacy of combination of bipolar RFITT and ethanol.

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Conflict of interest statement:

No conflicts declared.

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