Original Article* / *Çalışma - Araştırma

The effect of radiofrequency thermal ablation method on nasal mucociliary activity in patients with inferior turbinate hypertrophy

Alt konka hipertrofisi olan hastalarda radyofrekans termal ablasyon yönteminin nazal mukosiliyer aktivite üzerine etkisi

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Objectives: This study aims to investigate the effect of radiofrequency thermal ablation (RFTA) treatment on nasal mucociliary activity before and after treatment in inferior turbinate hypertrophy.

Patients and Methods: Thirty-nine patients (21 males, 18 females; mean age 36.3±13.9 years; range 16 to 67 years) admitted to our clinic with complaint of nasal obstruction and diagnosed with stromal inferior turbinate hypertrophy were included in this study. Effect of RFTA treatment on nasal mucociliary activity was investigated by saccharine test before treatment and two months after treatment. Grade of nasal obstruction was evaluated by visual analog scale (VAS) before treatment and two months after treatment. Results were compared with paired t-test.

Results: Mean mucociliary activity times were 9.8±4.4 minutes before treatment and 9.6±4.1 minutes two months after treatment, and the difference between two tests was not statistically significant (p=0.3). Mean VAS scores for nasal obstruction were 6.5±1.2 before treatment and 3.8±1.0 two months after treatment, and the difference between two results was statistically significant (p=0.001). Difference between sexes in terms of saccharine transit time and VAS values before and after treatment was not statistically significant (p>0.05).

Conclusion: It was detected that RFTA has no adverse effect on mucociliary activity in the treatment of inferior turbinate hypertrophy, and this method is notably effective in relieving the nasal obstruction caused by inferior turbinate hypertrophy.

Keywords: Hypertrophy; inferior turbinate; mucociliary activity; radiofrequency; saccharine test.

Amaç: Bu çalışmada alt konka hipertrofisinde radyofrekans termal ablasyon (RFTA) tedavisinin tedavi öncesi ve sonrası nazal mukosiliyer aktivite üzerine etkisi araştırıldı.

Hastalar ve Yöntemler: Kliniğimize burun tıkanıklığı yakınması ile başvuran ve stromal alt konka hipertrofisi tanısı konulan 39 hasta (21 erkek, 18 kadın; ort. yaş 36.3±13.9 yıl; dağılım 16-67 yıl) çalışmaya alındı. Radyofrekans termal ablasyon tedavisinin nazal mukosiliyer aktivite üzerine etkisi, tedavi öncesi ve tedaviden iki ay sonra sakarin testi ile araştırıldı. Burun tıkanıklığının derecesi görsel analog ölçeği (GAÖ) ile tedavi öncesi ve tedaviden iki ay sonra değerlendirildi. Sonuçlar eşleştirmeli t-testi ile karşılaştırıldı.

Bulgular: Ortalama mukosiliyer aktivite süreleri tedavi öncesi 9.8±4.4 dakika, tedaviden iki ay sonra 9.6±4.1 dakika idi ve iki test arasındaki farklılık istatistiksel olarak anlamlı değildi (p=0.3). Burun tıkanıklığı için ortalama GAÖ değeri tedavi öncesi 6.5±1.2, tedaviden iki ay sonra 3.8±1.0 idi ve sonuçlar arasındaki farklılık istatistiksel olarak anlamlıydı (p=0.001). Tedavi öncesi ve sonrası sakarin geçiş zamanı ve GAÖ değerleri açısından cinsiyetler arasındaki farklılık istatistiksel olarak anlamlı değildi (p>0.05).

Sonuç: Alt konka hipertrofisinin tedavisinde RFTA'nın mukosiliyer aktivite üzerinde olumsuz etkisinin olmadığı ve bu yöntemin alt konka hipertrofisinin neden olduğu burun tıkanıklığını gidermede oldukça etkili olduğu saptandı.

Anahtar Sözcükler: Hipertrofi; alt konka; mukosiliyer aktivite; radyofrekans; sakarin testi.

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Nasal obstruction is one of the most prevalent symptoms that otorhinolaryngologists encounter in clinical practice and it truly affects people's quality of life. Inferior turbinate hypertrophy is the most frequent cause of nasal congestion.[1] Inferior turbinate hypertrophy generally develops due to allergic rhinitis, vasomotor rhinitis and septal deviation (unilateral compensatory).[2,3] Extensive turbinate hypertrophy disrupts the physiologic functions of the nose, and factors such as respiration, olfaction, humidification of inspired air and resonance of the voice are altered according to the severity of hypertrophy.[4-6]

Various medical and surgical methods are used in the treatment of nasal obstruction due to turbinate hypertrophy. While medical treatment is preferred as first line therapy, surgical treatment is performed in cases refractory to medical treatment. Medical treatment methods include topical or systemic decongestants, antihistamines, topical steroids and immunotherapy. However, medical treatment methods do not succeed in every case, and surgical treatment is necessary for those. Numerous surgical techniques defined in the medical literature include cryosurgery, electrocautery, partial turbinectomy, laser turbinoplasty and radiofrequency thermal ablation (RFTA).[1,7,8] In RFTA, heat is created in the tissue by passing high frequency current through it and this, by ablation, causes a contraction in the target tissue volume.[9]

The aim of this study is to assess the effect of radiofrequency surgery on nasal mucociliary activity (MCA) in hypertrophic inferior turbinates before and after RFTA treatment. Moreover, the study also aims to evaluate inferior turbinate hypertrophy related nasal obstruction before and after RFTA treatment, and to determine the effectiveness and reliability of the RFTA technique.

PATIENTS AND METHODS

This study was conducted on 39 patients (21 males; 18 females; mean age 36.3±13.9 years; range 16 to 67 years) who were diagnosed with inferior turbinate hypertrophy when they consulted at the Otorhinolaryngology Department of the Medical School Hospital, Afyon Kocatepe University with complaints of nasal obstruction. Ethical approval was granted for the study and informed consent was obtained from all patients. Once the patients' medical historical information was gathered, anterior rhinoscopic and nasal endoscopic examinations were carried out, and the data was recorded. Only patients whose nasal obstruction was due to stromal inferior turbinate hypertrophy were included in the study. Turbinate hypertrophy was qualified as stromal in nature as a result of the regression of objective and subjective symptoms 10 minutes after the use of oxymetazoline nasal spray.[10,11] Exclusion criteria for the study group were as follows: active sinonasal infections, diseases that can cause nasal obstruction other than inferior turbinate hypertrophy such as allergic rhinitis and rhinosinusitis, long-term medication with local and systemic decongestants, oral and nasal steroids and antihistaminic drugs, those who had septal pathologies and anatomical anomalies, and smokers.

The patients were asked to evaluate their level of nasal obstruction for each nasal passage according to the given visual analog scale (VAS), with "0-zero" representing no nasal obstruction and "10-ten" having complete nasal obstruction, at two different times; once prior to RFTA treatment and once two months after treatment. The effect of radiosurgery on MCA was assessed with saccharine test by measuring MCA time. The test was conducted with patients in sitting position in a relaxed manner, avoiding any backward head movement, sneezing or sniffing. They were asked to swallow once approximately every minute and to report the taste as soon as they perceived it, and the interval between the beginning of the test and the point at which the taste was perceived was recorded as the saccharine transit time. For the test, ¼ saccharin tablet (Sakarin tablets, Münir Şahin Medical Inc., Turkey) was placed on the mucosa 1 cm behind the anterior end of the inferior turbinate, then the period of time until the taste was first perceived was measured and it was recorded as the saccharine transit time. The saccharin test was conducted twice; once prior to the RFTA treatment and once two months after treatment.

Radiofrequency thermal ablation was applied to the inferior turbinates in the operating room, under local anesthesia without sedation. Two puffs of 10% lidocaine spray (Xylocaine spray, Astra Zeneca, Sweden) were applied to each nasal passage. Subsequently, 2 mL local anesthetic

containing 40 mg lidocaine HCl and 0.025 mg epinephrine (Jetokain ampul, Adeka Medical Inc., Turkey) was injected in the anterior, middle and posterior portion of each turbinate with a 24-gauge injector. Consequently, a 10-minute break was given. For the RFTA technique, GYRUS ENT Somnoplasty device (Gyrus ENT Somnoplasty, ENT LLC/dba Gyrus ENT, Barlett, USA) was used. For the inferior turbinate, the recommended ablation probe with a specially designed tip with a diameter of 1.3 mm was used and the electrode was placed on a large muscle on the bodies of the patients (generally on their backs). In order to ensure that the application area could be easily observed on anterior rhinoscopy, the probe of the device was longitudinally and submucosally placed in the anterior, middle and posterior portions of the turbinate respectively, and the procedure was completed by applying 350 joules energy for 20 seconds in each area (Figure 1). Nasal pack was not used in all cases postoperatively. Patients were observed and nursed in the service room for 2-3 hours and were informed about the possible side effects (bleeding, crusting, pain, nose obstruction, etc.). The patients were provided with normal saline for nasal irrigation and were instructed to take paracetamol in case they had pain, but no additional treatment was given. The patients were told that they could return to their normal daily routines and sent to their homes on the same day. They were invited for control examinations on the first and eighth week after the operation.

Figure 1. *Radiofrequency thermal ablation application sites in the nose (white areas: anterior, middle and posterior portions of the inferior turbinate).*

Saccharine test results and VAS scores, collected from both nasal cavities before the operation and eight weeks after the operation, were statistically evaluated using paired t-test. When p value was less than 0.05, differences were considered to be statistically significant.

RESULTS

The VAS scores after the radiofrequency treatment for both nasal cavities were found significantly lower than those prior to the treatment; the scores decreased from 6.7±1.2 to 3.9±1.1 for the right cavity and from 6.3±1.2 to 3.8±0.9 for the left cavity ($p<0.001$ for both nasal cavities) (Table 1). When right and left nasal obstructions of the patients were compared by VAS, no statistically significant difference was found between the mean scores before and after treatment ($p>0.05$).

When MCA values of the patients measured by saccharine test before the RFTA treatment (9.8±4.4) and two months after (9.6±4.1) for both the right and the left nasal cavity were compared, no significant difference was found ($p>0.05$) (Table 2).

No significant difference was found between genders in terms of VAS scores and saccharine transit times ($p>0.05$).

DISCUSSION

After septal pathologies, inferior turbinate hypertrophy is the most common cause of nasal obstruction. Various medical and surgical methods are used in the treatment of nasal obstruction resulting from turbinate hypertrophies. Patients are frequently required to obtain surgical

Table 1. Comparison of right and left nasal cavity obstruction using visual analog scale before and after radiofrequency thermal ablation

Nasal cavity	Before RFTA	After RFTA (8^{th} week)	
	Mean±SD	Mean±SD	p^*
Right	6.7±1.2	3.9±1.1	<0.001
Left	6.3±1.2	3.8±0.9	<0.001
Mean	6.5±1.2	3.8±1.0	<0.001

RFTA: Radiofrequency thermal ablation; SD: Standard deviation; *p<0.05.

Table 2. Comparison of saccharine test mucociliary activity values (in minutes) for right and left nasal cavities before and after radiofrequency thermal ablation

Nasal cavity	Before RFTA	After RFTA (8^{th} week)	
	Mean±SD	Mean±SD	*p**
Right	9.6±4.0	9.6±3.9	1
Left	10.0±4.8	9.6±4.4	0.97
Mean	9.8±4.4	9.6±4.1	0.3

RFTA: Radiofrequency thermal ablation; SD: Standard deviation; *p<0.05.

treatment. Many surgical techniques are defined in the medical literature such as total and partial turbinectomy, turbinoplasty, submucosal resections, laser turbinoplasty, vidian neurectomy, cryosurgery, topical silver nitrate ($AgNO_3$) application, steroid and sclerosant injection, lateral out-fracture, monopolar and bipolar cauterization, and thermal ablation treatment via radiofrequency energy.[7,8] The fact that there are plenty of identified and applied treatment choices in the surgical treatment of turbinate hypertrophies indicates that there is not an ideal method alone. The ideal method in turbinate surgery should be one that reduces turbinate volume, protects physiological functions, and does not lead to complications.[12] Just focusing on widening the nasal passage is a major mistake. Although successful results can be obtained in turbinate reduction using the majority of these techniques, recurrent side effects have been reported such as bleeding, crusting, dryness, bad smell, pain, hyposmia, synechia and bone necrosis.[13] Impaired MCA in the damaged mucosa has been implicated in many postoperative side effects.[14] Nasal MCA is a significant defense system that protects the respiratory system against bacterial, viral and other kinds of unfamiliar particles. Therefore, surgical procedures that aim to protect the mucosa of the turbinates such as partial turbinoplasties and submucosal techniques have recently been more commonly used.

Şapçı et al.[15] reported that MCA was most impaired with laser application in their study using radioisotope method (Technetium 99m), and obtained similar results to the control group with the RFTA applied group. They further found that RFTA improved nasal obstruction by protecting MCA as well as other methods. In the literature, the saccharine test was also used commonly in the evaluation of MCA.[12,16,17] The saccharine test is frequently preferred for MCA measurement as it is a cheap, easy and a reliable method.[18] One of the most important advantages of the test is that it does not require topical anesthesia for application; thus, it does not allow for any possible ciliary function loss due to such topical anesthetic agents.[19] The period of time that passes between the placement of saccharine into the nasal passage up to the perception of taste is saccharine transit time and takes 7-15 minutes; any time longer than 20 minutes indicates that MCA is impaired.[18] In a comparative study; Rhee et al.[17] applied RFTA on 16 patients and laser turbinoplasty on eight patients due to inferior turbinate hypertrophy, and reported that the saccharine transit time in the second month did not change in the group in whom RFTA was applied; in other words, they demonstrated that RFTA did not affect MCA. They also reported that they were not able to evaluate MCA by saccharine test in the group on whom the laser treatment was applied due to the crust and scars on the turbinate even in the second month. Moreover, Cavaliere et al.[12] studied a total of 75 patients, divided into a control group, a group on whom surgical partial turbinoplasty was applied, and a RFTA group. They reported that MCA values of the group that underwent surgical partial turbinoplasty were considerably high at the end of the first week whereas no significant difference was found between the control group and the group on whom RFTA was applied. However, they also found that saccharine transit times in all three groups leveled to similar values at the end of the first month. Similarly, the results of our study revealed no significant difference between the average MCA values before and after RFTA treatment, and our findings appear to correspond to the results reported in the literature. According to the results of the current study, it can be concluded that RFTA does not have any effects whatsoever on MCA, which plays a significant role in nasal functions. There may be an explanation as to why common post-turbinate-surgery patient complaints such as crust formation, dryness, bad smell, pain, and synechia are less likely to be seen after RFTA. In fact, there are many published articles that support such findings on a histopathologic level. Coste et al.[16] showed that ciliary cells on the surface epithelium of turbinate

mucosa not only were intact at the early stages of post-RFTA, but also had normal beat frequency; thus, they concluded that RFTA was a safe and effective treatment method. Another study that investigated the effects of radiofrequency on nasal mucosal changes demonstrated in transmission electron microscopy that ciliary and goblet cells on nasal epithelium were intact in the first year after treatment.[20]

Radiofrequency energy imposes its effect of decreasing tissue volume by creating submucosal thermal lesions, fibrosis and wound contraction. A range of results have been reported wherein recovery time from symptoms were evaluated in patients on whom radiofrequency tissue ablation therapy was applied due to inferior turbinate hypertrophy. Back et al.[21] reported a decrease in the patients' nose obstruction within 12 months after radiofrequency turbinate ablation, yet they specified that the most significant improvement was observed at the end of the third month. On the other hand, Karadeniz et al.[22] stated that the most prominent improvement happened at the end of the first month and improvements continued until the third month. Powell et al.[23] carried out an experimental study investigating the tissue reaction to radiofrequency, and found that tissue volume started to reduce 10 days after application and that reduction continued until the 21st day. Porter et al.[24] treated inferior turbinate hypertrophies of 19 patients by RFTA, and observed that VAS scores of the patients obtained by VAS evaluation significantly dropped at the end of the eighth week, and these scores did not undergo any significant change throughout the next two years. Seeger et al.[25] followed up 38 patients who underwent RFTA to inferior turbinates for 20 months and reported that 69% of the patients recovered to an excellent degree, whereas 29% had partial recovery. Moreover, no significant difference could be found between the VAS scores of the patients in the second and 20th months. Süslü et al.[26] treated 89 patients by RFTA and monitored them for 30.5 months on average-- they found out that VAS scores of the patients obtained at the first application dropped significantly at the end of the second month, and no significant difference could be found between the reduced VAS scores and the ones obtained on final examination. Lin et al.[27] treated 146 patients diagnosed with allergic rhinitis refractory to medical therapy with RFTA turbinoplasty, and after a follow-up of 101 patients for at least five years, they concluded that it was an effective and a safe tool. The literature states that VAS, rhinomanometry, and acustic rhinometry are the commonly used methods to evaluate the efficiency of surgery implemented before and after turbinate surgery.[15,16,24] In our study, the nasal obstruction symptoms of the patients were evaluated by VAS before and two months after treatment. The results indicate that the initial VAS scores, which had a mean value of 6.48, were reduced to 3.83 two months after treatment. Our findings are consistent with other findings in the literature, which specify that the efficiency of RFTA emerges approximately in the eighth week. It has been concluded that at least two months should pass before evaluating the efficiency of RFTA or reoperating the same turbinate if necessary, and before any further application should be considered.

A review of the literature reveals that there are studies in which radiofrequency was applied to each turbinate at one single point, as well as studies with multiple point applications.[7,28,29] Nease and Krempl[28] reported that single-point RFTA provided fairly efficient and successful results in treating nasal obstruction due to turbinate hypertrophy in a study consisting of 32 patients. Utley et al.[7] suggested that two-point application resulted in better than single-point application. Coste et al.[16] performed applications on each turbinate at three different points, identified reduction in turbinate volume after 60 days, and showed that the mucosa was healthy by saccharine test. In our study, RFTA was applied in anterior, middle and posterior areas of the inferior turbinate. In spite of the fact that we did not compare single-point RFTA application with multiple-point applications, our results demonstrated that three-point application provided a sufficient degree of reduction in turbinates.

Mild complications may arise in radiofrequency surgery. Generally, nasal obstruction occurs postoperatively in the first week, and later heals. Li et al.[30] reported that mild edema is seen in the first 24-48 hours after radiosurgery, and this leads to a temporary increase in nasal obstruction complaints. Mild pain can be controlled using analgesics. Lightheadedness and numbness of maxillary teeth during the

operation has been reported in some cases in the literature.[2,24] The above-mentioned symptoms such as lightheadedness, numbness in maxillary teeth, crusting, bleeding or mucosal erosion were not observed in any of our patients during or after the operation. Only six patients (15.38%) experienced an increase in nasal obstruction in the first week, but it completely healed in the second week.

According to our findings, it can be concluded that RFTA treatment is an effective method which improves nasal obstruction not only without damaging MCA, which is a significant factor in nasal physiology, but also without causing any of the complications reported in the literature such as bleeding, crusting, dryness, bad smell, hyposmia, and synechia.

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