Original Article / Çalışma - Araştırma

Acoustic rhinometry evaluation of radiofrequency ablation of the turbinates

Radyofrekansla konka ablasyonunun akustik rinometri ile değerlendirilmesi

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Objectives: The objective of this study is to determine if acoustic rhinometry (AR) can predict the outcome of radiofrequency ablation (RFA) of the inferior turbinates.

Patients and Methods: Preoperative AR measurements of 19 subjects undergoing inferior turbinate RFA were analyzed before and after decongestant. The average total percentage change in cross sectional area (CSA) 1 and in total volume was calculated for each. Both the physician and patient assessed treatment success subjectively. If available, postoperative data was analyzed.

Results: The congestion factor of CSA1 was 72.76±75.58 before surgery and 42.32±27.79 after surgery ($p>0.05$). There were no significant differences in CSA1, CSA2, CSA3 and total volume after the radiofrequency ablation surgery. All patients were satisfied with the results of the surgery. Physician assessment was ‘satisfactory’ for 18 patients and ‘partially satisfactory’ for one.

Conclusion: Nineteen patients had AR and RFA of the turbinate. Since all patients were satisfied with the operation, no conclusion can be drawn regarding the predictive value of AR. Although there was a trend to a larger volume postoperatively, none of the measured parameters were significantly different.

Key Words: Acoustic rhinometry; nasal obstruction; radiofrequency ablation; turbinate hypertrophy; turbinate surgery.

Amaç: Bu çalışmada akustik rinometrinin (AR), radyofrekans ablasyon tedavisinin (RFA) ameliyat sonrası dönemdeki sonucunu öngörme olasılığı saptandı.

Hastalar ve Yöntemler: Alt konka RFA tedavisi öncesi akustik rinometrik ölçümleri yapılan 19 olgunun dekonjestan öncesi ve sonrası değerleri tespit edildi. Enine kesit alanı (EKA) 1 ve total hacimdeki ortalama total yüzde değişiklikleri hesaplandı. Tedavi başarısı hekim ve hasta tarafından subjektif olarak değerlendirildi. Eğer var ise ameliyat sonrası bulgular da analiz edildi.

Bulgular: Enine kesit alanı 1 için konjesyon faktörü cerrahi öncesi 72.76±75.58 iken cerrahi sonrası 42.32±27.79 idi ($p>0.05$). EKA1, EKA2, EKA3 ve total hacim ölçümlerinde RFA sonrası anlamlı fark görülmedi. Hastaların tamamı cerrahinin sonuçlarından “memnun”du. Hekim değerlendirmesi ise 18 hasta için “memnun”, iken bir hasta için “kısmen memnun” şeklinde idi.

Sonuç: On dokuz hastaya AR ve konka RFA uygulandı. Tüm olgular ameliyattan memnun olduğu için AR’nin prediktif değeri hakkında bir sonuca varılamadı. Ameliyat sonrasında daha geniş bir total hacme meyil olduğu görülmüş olsa da, ölçülen AR parametrelerinin hiçbirinde anlamlı bir artış tespit edilemedi.

Anahtar Sözcükler: Akustik rinometri; nazal obstrüksiyon; radyofrekans ablasyonu; konka hipertrofisi; konka cerrahisi.

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Inferior turbinate hypertrophy is a very common cause of nasal obstruction. It is often associated with allergic rhinitis, vasomotor rhinitis and rhinosinusitis. When medical treatment fails, surgical treatment may play a role. Several surgical approaches have been utilized for inferior turbinate hypertrophy; including anterior turbinoplasty, electrical cauterization, laser surgery, vidian nerve neurectomy, coblation, submucosal resection, cryotherapy and radiofrequency ablation. Radiofrequency ablation surgery is a relatively new method for turbinate surgery. In this method, radiofrequency heating is used to induce ion agitation within the turbinate tissue, which increases the local temperature and causes a thermal lesion without damaging the surface.[1] The healing process induces fibrosis, leading to a reduction in tissue volume.

Acoustic rhinometry is used as a reliable method for showing the changes in the nasal cavity pre- and postoperatively. Several studies describe the utility of acoustic rhinometry for assessing the nasal cavity.[2-5] Acoustic rhinometry assesses both the reversible and irreversible hypertrophies and could aid in selecting the appropriate candidates for successful radiofrequency ablation. The main objective of this study is to assess the outcome and efficacy of radiofrequency surgery for the treatment of inferior turbinate hypertrophy and to determine if acoustic rhinometry can predict the outcome for radiofrequency ablation of the turbinate surgery.

PATIENTS AND METHODS

A retrospective chart review of adult subjects between the ages of 18-65 with symptoms of nasal obstruction who had acoustic rhinometry for evaluation of the nasal geometry between the years 2000 and 2005 was performed. The study approval was secured from the University of Chicago Institutional Review Board. A total of 205 patients were identified. Out of these patients, the ones who underwent radiofrequency ablation surgery of the inferior turbinate were determined.

The acoustic rhinometry results, the age, sex, weight, height, the number of procedures and joules used for the therapy, patient's assessment of success, physician's assessment of success and presence or absence of comorbid like conditions: sinusitis, nasal allergies or deviated nasal septum were recorded. Patients with septal perforation, nasal sarcoidosis and nasal motility disorders were excluded.

The acoustic rhinometry measurements were performed before and after the radiofrequency turbinate surgery. Patients were instructed to discontinue allergy medications including topical intranasal steroids and decongestants three days before testing. The cross sectional areas (CSA) 1, 2 and 3 were measured at 2, 4 and 6 cm, respectively where the CSA1 corresponded to the area of the nasal valve, CSA2 to the anterior head of the inferior or middle turbinate and CSA3 to the mid-posterior end of the middle turbinate. The total volume was measured in the distance between 0 to 6 cm's.

The percentage change in CSA and Total volume (Congestion Factor)[6] was calculated using the following formula;

$$\text{Congestion factor} = \frac{\text{Decongested CSA value-baseline CSA value} \times 100}{\text{Baseline CSA value}}$$

All surgeries were performed by the JPC senior researcher. The radiofrequency probe was inserted into the anterior inferior turbinate, parallel to the long axis towards the depth of the probe after the application of topical and local anesthetics. No sedation, corticosteroids or antibiotics were used if the turbinates were treated alone. The follow-up evaluation was performed during a surgery visit at two-three weeks and a second visit four or six weeks after the procedure. In this follow-up, specific attention was given to the existence of any pain, bleeding, crusting, dryness, odor, infection or change in the sense of smell.

The main outcome parameters defined for this study were the patients' and the physicians' assessment of success. Treatment success was scored as satisfied, partially satisfied or not satisfied, and was assessed by both the patients and the physicians.

Statistical analysis was performed using t-test with Stata 9.0 (Stata corporation, Texas, USA). $P<0.05$ was considered significant. The cross sectional areas and total volume values are given as mean ± standard deviation.

RESULTS

We were able to identify 21 procedures in 19 patients with acoustic rhinometry performed before surgery.[7] Patients had postoperative acoustic rhinometry results. The patients'

Table 1. Patient characteristics

Characteristic	Sex	Average	Range
Age (year)		46	22-71
Weight (lb)		178.9	143-220
Height (in)		65.4	63-69
Female/male	11/8		

characteristics are listed in Table 1. Two of the 19 patients had a second surgery. The time for evaluation after surgery was 8.61±1.87 weeks. The joules we used were 349±70.9 joules with two or three applications to each turbinate. The preoperative diagnoses were as follows: hypertrophy of inferior turbinate in 19 cases, septum deviation in combination with turbinate hypertrophy in nine cases, allergic rhinitis in combination with inferior turbinate hypertrophy in nine cases.[7] of the patients with allergic rhinitis were on immunotherapy.

The preoperative mean values of CSA1 of the smallest side of all (n=19) subjects before surgery before decongestant and after decongestant were 0.60±0.2 and 0.80±0.31 cm^2, respectively. The change in CSA1 before and after decongestant before surgery was statistically significant (p=0.01). The preoperative mean of CSA2 in all subjects before surgery before decongestant and after decongestant were 1.01±0.56 and 1.72±0.53 cm^2 respectively. The change in CSA2 before and after decongestant before surgery was statistically significant (p=0.00). The preoperative mean CSA3 of all subjects before surgery before decongestant and after decongestant were 1.56±0.70 and 2.49±0.54 cm^2 respectively. The change in CSA3 before and after decongestant was statistically significant (p=0.000). The preoperative mean of total volume of all subjects before surgery before decongestant and after decongestant were 7.31±1.90 and 10.19±2.26 cm^2, respectively.

Table 2. Preoperative congestion factor in CSA1 in all subjects (n=19; 21 procedures)

	Before surgery	
Congestion factor	n	CSA1(cm^2)±SD
Normal (0-50)	9	14.2±11.3
Mild (51-75)	4	62.19±7.61
Moderate (76-125)	6	97.20±10.2
Severe (126-180)	2	264±52
Total	21	–

CSA: Cross sectional area; SD: Standart deviation.

The change in total volume before and after decongestant before surgery was statistically significant (p=0.00).

The preoperative mean congestion factor values for CSA1, CSA2, and CSA3 in all (n=19; 21 procedures) subjects were 60±85.2, 119.16±188.05 and 93.2±133.6 respectively. The preoperative congestion factor values in CSA1 of these subjects are grouped according to their severity in Table 2. The percentage of patients with normal, mild, moderate and severe congestion factor in CSA1 were 42%, 19%, 28% and 22%, respectively.

Postoperative analysis was available for seven subjects. The statistical comparisons for the pre- and postoperative values of all measured areas in these seven subjects are listed in Table 3 and shown in Figure 1. There were no statistically significant changes in CSA1, CSA2, CSA3 or the total volume comparing pre- and postoperative before and after decongestant values.

The comparison of the mean congestion factor of subjects whose postoperative results were available is shown in Table 4. There was no significant difference between the pre- and postoperative CSA1, CSA2, CSA3 and total volume congestion factor values. However, postoperative CSA 1, CSA3 and total volume congestion factors showed

Table 3. Comparison of acoustic rhinometry values (n=7)

	Before surgery			After surgery			BS versus AS *p*	
	BD	AD	*p*	BD	AD	*p*	BD	AD
CSA1	0.60±0.31	0.87±0.21	0.01	0.65±0.26	0.89±0.26	0.001	NS	NS
CSA2	1.23±0.51	1.78±0.53	NS	1.42±0.57	2.10±0.71	0.002	NS	NS
CSA3	1.70±0.38	2.62±0.34	0.000	1.85±0.54	2.81±0.62	0.000	NS	NS
TV	8.00±1.33	11.19±2.01	0.000	8.64±1.70	11.06±2.40	0.000	NS	NS

CSA: Cross sectional area; TV: Total volume; BS: Before surgery; AS: After surgery; BD: Before decongestant; AD: After decongestant; NS: Non-significant.

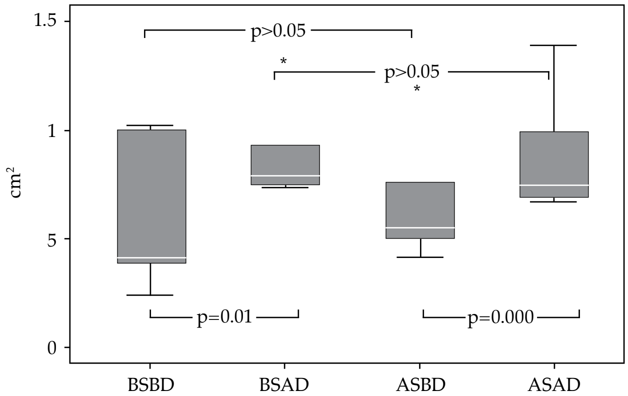

Fig. 1. *Comparison of CSA1 values before and after surgery. BSBD: Before surgery before decongestant; BSAD: Before surgery after decongestant; ASBD: After surgery before decongestant; ASAD: After surgery after decongestant; CSA: Cross sectional area.*

a trend to be lower than the preoperative congestion factor, consistent with a smaller change after the application of decongestant. The standard deviation of postoperative values in CSA1 and CSA3 had a trend to be smaller than the preoperative values.

The congestion factor in CSA1 subjects with both pre- and postoperative values was grouped as described before (Table 5). Before surgery 42% (n=3) of patients had a normal congestion factor, 42% (n=3) of patients had a moderate congestion factor and 14% (n=1) patient had a severe congestion factor. After surgery 71% (n=5) of patients had a normal congestion factor and 28% (n=2) of patients had a moderate congestion factor.

The postoperative change in congestion factor in CSA1 of each patient is shown in Figure 2.

All patients were satisfied with the surgery. The physicians' assessment was satisfactory for 18 subjects and partially atisfactory for one subject due to asymptomatic crusting in the nasal cavity.

Table 4. Comparison of congestion factors in all measured areas (n=7)

	Before surgery	After surgery	*p*
CSA1	72.76±75.58	42.32±27.79	NS
CSA2	54.11±24.23	52.76±33.57	NS
CSA3	66.13±49.08	34.65±10.56	NS
TV	40.35±12.42	29.64±24.76	NS

CSA: Cross sectional area; TV: Total volume; NS: Non-significant.

Postoperative side-effects

A total of two patients reported mild crusting in the nose. We found no nasal obstruction and no bleeding or pain after surgery.

DISCUSSION

Most of the cavernous and erectile tissue in the nose is located in the lateral nasal wall and turbinate. The congestion factor, which is the difference between baseline and decongested CSA and volume value measurements, reflects the amount of reversible mucosal congestion.[6] Previous studies have shown that being these differences, rather than absolute values, are more clinically relevant dependent.[7,8]

The preoperative values of all subjects for congestion factor in CSA1 are listed in Table 2. Fifty eight percent of our patients that had undergone turbinate reduction surgery had a congestion factor outside the normal range. All subjects had the complaint of congestion preoperatively.

Twelve subjects were satisfied after one radiofrequency ablation session and were not further evaluated. Seven subjects were evaluated with a second acoustic rhinometry postoperatively. Two patients of the 19 had a second radiofrequency ablation session and a third acoustic rhinometry after the 2nd procedure. The subjects who received

Table 5. Percentage change of CSA before and after surgery after decongestant application

	Before surgery		After surgery	
Congestion factor	Number of subjects	CSA1(cm^2)±SD	Number of subjects	CSA1(cm^2)±SD
Normal (0-50)	3	7.61±18.52	5	26.55±8.10
Mild (51-75)	NA	NA	NA	
Moderate (76-125)	3	91.33±12.07	2	81.74±4.48
Severe (126-180)	1	212.5	NA	
Total	7		7	

CSA: Cross sectional area; SD: Standart deviation; NA: Not available.

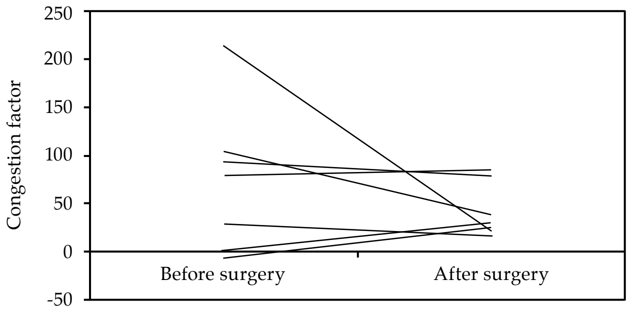

Fig. 2. *Comparison of individual change in congestion factor in CSA1.* CSA: Cross sectional area.

a second evaluation were biased towards possible failures.

The cross sectional areas 1, 2, 3 and the total volume did not show significant differences from the postoperative values. Objective measurements of nasal obstruction were assessed in another study of radiofrequency turbinate reduction.[1] This study showed a significant improvement in minimal cross sectional area. Our results showed a trend only. This may be due to bias, as only possible failures were worked up with a second acoustic rhinometry. The small number of subjects is also a possible source of difference. An alternative explanation for the differences may be the technical variations due to the measurement techniques. In our study, we have used the actual distances of 2, 4 and 6 cm for the evaluation of CSA1, 2 and 3, respectively. It is possible that the actual change in CSA1 may shift to the right or may occur at a slightly different distance, such as 2.4, 4.6 and 6.8 cm's. The most minimal CSA could also shift from CSA1 to CSA2. The discrepancy may also have been caused by a compensatory enlargement of the middle turbinate. Other possible causes could include a loss of sensation in nerve endings of inferior turbinate mucosa which could result in significant improvement in subjective symptoms.

In this study, we compared the pre- and postoperative congestion factors of seven of our patients suggestive of less erectile tissue. Although the congestion factor of CSA1 had a moderate decrease, the difference was not statistically significant possibly due to the high value of the standard deviation. We have observed that the amount of variation in the congestion factor had a trend to be smaller than the preoperative values, which suggests that the response to the decongestant has a trend to decrease. We suggest that the radiofrequency ablation of the turbinates may not directly affect the CSA or the total volume, but may decrease the response of the erectile tissue to stimuli, which results in improvement in an nasal congestion symptoms postoperatively.

We were unable to predict the outcome of the radiofrequency treatment by using acoustic rhinometry. The postoperative CSA values showed a trend to be higher than the preoperative values, but this was not statistically significant.

This study used a very small retrospective study group. A much larger group may have detected other significant changes.

In conclusion, 19 patients undergoing 21 radiofrequency ablation procedures were satisfied with the outcome. Evaluation with acoustic rhinometry showed a trend towards a smaller area and volume and a lower congestion factor, but significance was not achieved in this small retrospective study. Factors other than volume and area change, such as a possible loss of sensation or decreased response to stimuli may contribute to the success of the procedure in relieving the subjects' improvement in the sensation of obstruction.

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