Effect of therapeutic pulsed ultrasound on smell dysfunction in subject with chronic rhinosinusitis

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Abstract

Olfactory dysfunction is one of the main symptoms of chronic Rhino sinusitis (CRS) caused by bacteria in the form of biofilm. Therapeutic pulse ultrasound (TPU), having anti-inflammatory effects and the ability to disrupt the strong walls of biofilms (community of bacteria), that can help relieve the symptoms of chronic sinusitis, one of the major symptom of which is olfactory dysfunction. Methods: A 47 year-old man who had contracted with CRS and subsequently his olfactory sense had declined gradually in the course of two years, underwent the pulsed ultrasound treatment for ten sessions, three days a week, on his Maxillary and frontal sinuses. CT-Scan and the Sino Nasal Outcome Test (SNOT-20) questionnaire were used to measure the severity of the symptoms as well as the Iran Smell Identification Test (ISIT) was used to measure the degree of olfactory dysfunction Result: smell dysfunction and the severity of symptom in CRS were improved according to SNOT-20 and ISIT scales relatively; 80% improvement and 41% respectively. Conclusion: it seems that TPU can be effective to improve the olfactory dysfunction caused by CRS and the other symptoms of this, before and after treatment.

Introduction

Sense of smell is one of the important senses in charge of ensuring our safety (making us conscious of the environment), helping in perception of tastes, increasing sexual power (1), as well as time and place management. Olfactory dysfunction leads to decrease in life quality and ultimately lack of social efficiency and depression (2) .Different reasons lead to olfactory dysfunction and one of them is CRS. Chronic Rhino sinusitis is one of the ten most common diseases around the world and inflicts about 12/5 million people in Europe and USA each year (3). CRS have two types of symptoms: 1. Major 2. Minor. Olfactory dysfunction is a major symptom in this. About 65 to 85 percent of people who contract chronic Rhino sinusitis experience olfactory dysfunction (3). The stronger the CRS condition, the greater the degree of olfactory dysfunction (4). The biofilm form of bacteria is the most repetitive cause of contracting CRS (3) Biofilm has high resistance against environmental threats such as the body's immune system and antibiotics (4). The inflammation caused by the existence of bacteria in the mucus of the sinuses and the nose, block the olfactory molecules from reaching the surface layer of the epithelium, in addition to the edema caused by the inflammation will result in olfactory nerve synapses disorder, which in turn disrupts the transmission of the olfactory message (5). Common treatments that help recover from CRS include antibiotics, steroids, and saline (6).

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Different factors such as the resistance of biofilm bacteria to common treatments (7), the failure of the treatments (8), as well as the side effects of using steroids such as stomach ulcers, osteoporosis, and immune system deficiency, have all affected the use of common treatment (9).The researches done on the effects of continuous and pulse ultrasound therapy indicate acceptable results in alleviation of symptoms and improvement of olfactory sense (10-15).

Case Description

A 42 year-old man who had suffered from chronic sinusitis which diagnosed by a specialist) and CT scan finding, with smell dysfunction. In that period, to alleviate his symptoms, the patent used various drugs such as: antibiotics, nasal saline, and inhaled and edible steroids. recurrence and persistence of olfactory dysfunction was showed that the failure of these common drugs.

Examination Diagnosis of CRS was diagnosed by an ENT specialist and CT-Scan clinical findings. The patient was referred to a physiotherapy clinic. CT-Scan was rated from 0 (clean) to 3 (total obscurity) by the specialist physician(16,43) before and after treatment (table 2). CT-Scan images before and after the treatment are represented in figure 2. The severity of the symptoms of chronic sinusitis was determined by the valid questionnaire SNOT-20 (17,47) (from 0: no symptom, to 5: most intense symptom) (table 1), The scores of the questionnaire was in (table3) and olfactory sense involvement was rated by Persian version of the University of Pennsylvania's was named ISIT(18,41) (Iran Smell Identification Test) (from 0 to 24), (figure1) in the first, last sessions, and one month after the last therapy session (table4).

TABLE 1: Sino Nasal outcome test

	no problem	very mild	mild	moderate	severe	bad as it can
1. Need to blow nose	0	1	2	3	4	5
2. Sneezing	0	1	2	3	4	5
3. Runny nose	0	1	2	3	4	5
4. Cough	0	1	2	3	4	5
5. Post-nasal discharge	0	1	2	3	4	5
6. Thick nasal discharge	0	1	2	3	4	5
7. Ear fullness	0	1	2	3	4	5
8. Dizziness	0	1	2	3	4	5
9. Ear pain	0	1	2	3	4	5
10.Facial pain/pressure	0	1	2	3	4	5
11.Difficulty falling asleep	0	1	2	3	4	5
12. Wake up at night	0	1	2	3	4	5
13. Lack of a good night's sleep	0	1	2	3	4	5
14.Wake up tired	0	1	2	3	4	5
15. Fatigue	0	1	2	3	4	5
16. Reduced productivity	0	1	2	3	4	5
17. Reduced concentration		1	2	3	4	5
18. Frustrated/restless/irritable	0	1	2	3	4	5
19. Sad	0	1	2	3	4	5
20. Embarrassed	0	1	2	3	4	5



Figure 1: Persian version of Pennsylvania smell identification test (ISIT)

Table 2: CT scan scores for a patient with chronic rhinosinusitis before and after treatment

	Right		Left	
Sinus	Before	After	Before	After
	Intervention 10 session			Intervention 10 session
Maxillary	3	1	1	1
Anterior ethmoid	1	0	1	0
Posterior ethmoid	1	1	1	1
Sphenoid	1	0	1	0
Frontal	0	0	0	0
Ostiomeatal complex	3	0	3	0
Total score	9	2	7	2

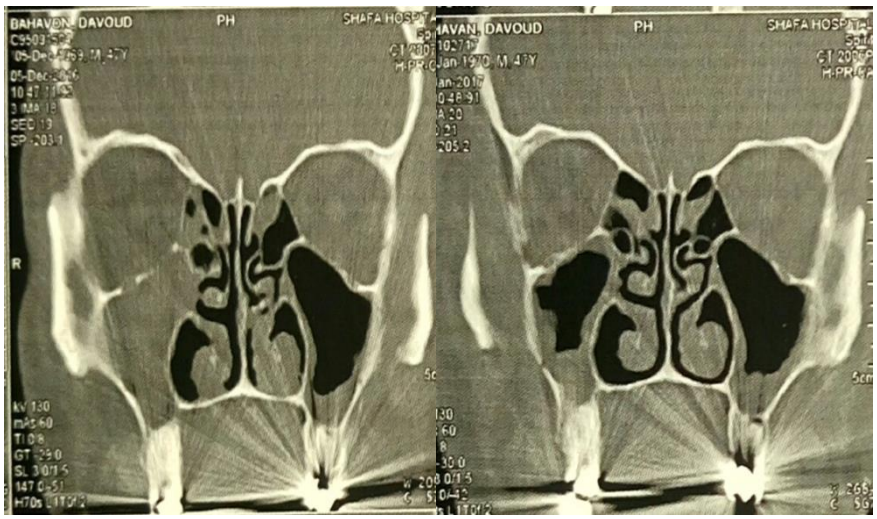


Figure2: (A) CT scan of patient with CRS with the opacification of the right maxillary sinus (grey area); (B) a repeat CT scan after US therapy demonstrates partial improvement of the right maxillary sinus (black area).

Prognosis

Therapeutic goals in this study included improvement of olfactory sense caused by CRS and alleviation of other symptoms of chronic rhinosinusitis, such as the post-nasal drip, headache, ear fullness, fatigue, and also clarity of the maxillary sinuses in the clinical findings.

Intervention

The ultrasound device used was an ITO 750. The applicator surface was 1cm2 and ERA (Effective Radiation Area) was 0.9 cm and the beam non uniformity ratio was 3.6, that is very low. For each of the Maxillary sinus the physiotherapist applied 1w/cm2 for five minutes and 0/5 w/cm2 for 4 minutes, applied 10% pulsed ultrasound in the site of the surface anatomy of the maxillary and frontal sinuses for ten sessions, three days a week.

Instrument of the study

The valid and Persian version of the Sino Nasal Outcome Test (SNOT-20) was used in order to analyze the intensity of the symptoms. In this questionnaire, 15 questions were allocated to visible symptoms such as: sneezing, coughs, need to empty the nose, etc. and 5 questions dedicated to life quality and psychological effects of the disease such as: decline in focus, desperation, and fatigue. Severity of symptoms was rated from 0 to 5 (0: no problem, 1: very little problem, 2: little problem, 3: moderately problematic, 4: intensely problematic, 5: very intensely problematic). Sum of scores was 100 was Problem as bad as it can be, and 0 was No Problem, The validity and reliability of SNOT-20 has been approved. Score of SNOT-20 before our treatment was 24, after that was 3 and 1 month fallow up was 2(table3). The extent of the olfactory dysfunction was evaluated before, after, and one month after the last session of the therapy, using the Persian version of Pennsylvania smell identification test. In this test, 24 different aromas were used and on the basis of the scores, olfactory dysfunction was rated from 0-7: anosmia (loss of olfactory sense), 8-13: severe hyposmia (decrease in smell sense), 14-19: mild hyposmia , 19-24: normosmia (normal smell sense) . The patient choses the closest smell among accessible choie being at the bottom of every sticker and then based on received scores, the severity of olfaction dysfunction is recognized in extend of normosmia to anosmia. The patient scores was 13 and placed in 'severe hyposmia' class and after 10 session the score was 24 and this shown improvement of smell dysfunction.(table 4).

Table 3: Scores of SNOT-20, before, after and 1 month fallow up

SNOT-20	before	after (10 session)	1month fallow up
Scores	24	3	2

Table 4: Scores of ISIT, before, after and 1 month fallow up

ISIT	before	after (10 session)	1month fallow up
Scores	13	24	24

Discussion

Olfactory dysfunction caused by chronic sinusitis is the result of inflammation and the edema subsequent to the inflammation, and this condition maybe leads to dysfunction of smell messages (12) synaptic space, and considering the anti-inflammation effects of TPU, and according to studies (26-30) that shown that therapeutic ultrasound can be effective in symptoms of chronic rhinosinusitis and smell dysfunction subsequence of CRS. Due to the high prevalence of olfactory dysfunction in chronic sinusitis(is a major symptom in CRS) and the limited effects of common therapeutic methods in treating the disorder and the possibility of recurrence of symptoms after taking medications, the need for alternative treatment is felt. It seems that pulsed ultra sound can be effective to the symptoms of CRS for these reasons: 1. Mechanical energy disrupts biofilm that act as a protective factor preventing drugs and immune system to affect the patient sinuses. With destroy this protective factor, bacteria can cause more damage(Qian, Stoody and Pitt 1996) 2. Bacteria cause inflammation, and TPU has anti-inflammation effects and by altering the cell membrane permeability leads to the regeneration of the tissue(Chung et al 2012). 3. Mechanical effects cause the separation of sticky secretions from the sinuses and facilitates emptying and drainage (Naghdi, Ansari, Farhadi, 2007). The effects of TPU modality have not been specifically and objectively applied to olfactory dysfunction so far. In this study olfactory dysfunction and its degree were evaluated using native and valid tests. It seems that non-invasive TPU can be effective to olfactory dysfunction and other symptoms of CRS.

Conclusion

This case report stud with 1 month fallow up shows that plused ultrasound can possibly effective to olfactory dysfunction and other symptoms of chronic sinusitis. Improvement was observed in Maxillary sinus by clinical finding and clinical symptom. As a suggestion, Further research needs to be done with regards to this therapeutic intervention.

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