



The effect of apple cider vinegar in the treatment of chronic rhinosinusitis

Amin Ostovar Shirazi¹, Hesam Jahandideh^{1,2}, Amir Yarahmadi¹, Maryam Milanifard³, Mojtaba Maleki Delarestaghi^{1,4}✉

¹Ent and Head & Neck Research Center, The Five Senses Institute, Iran university of Medical sciences, Tehran, Iran

²Department of otolaryngology Head and Neck surgery, Firrozgar Hospital, Iran University of Medical sciences, Tehran, Iran

³Anatomy Department, school of Medicine, Iran university of Medical sciences, Tehran, Iran

⁴Ent and Head & Neck Research Center and department, Firoozgar clinical Research (FCRDC), Tehran, Iran

✉ Corresponding author

ENT and Head & Neck Research Center, the Five Senses Institute, Iran university of Medical sciences, Tehran, Iran / Ent and Head & Neck Research Center and department, Firoozgar clinical Research (FCRDC), Tehran, Iran

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General Note



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ABSTRACT

Introduction & Objective: Chronic rhinosinusitis is one of the most common chronic diseases which involve 12 to 17 percent of the population. Topical treatments like irrigation and inhalation may have a role in affecting the biofilms and so can be effective in treating chronic infection and chronic rhinosinusitis. The purpose of this study was to determine the effectiveness of using apple cider vinegar in the treatment of patients with chronic rhinosinusitis with or without polyposis. *Methods:* In the present study, 100

patients with chronic rhinosinusitis in the age range of 25 to 54 years with a mean age of 35.3 years were included. They were divided into control and intervention groups. SNOT-22 questionnaire was used to evaluate the complications and symptoms of rhinosinusitis. For grading polyposis Meltzer grading criterion was used collected data were entered into SPSS 20 software and analyzed by Chi square test. The normality of the mean distributions was assessed using Kolmogorov-Smirnov test. **Results:** There was no significant difference between the age and sex in the two groups and the two groups were homogeneous. In the present study, the results of the chi-square test showed that there was a statistically significant difference between the two groups ($P=0.001$). In the control group, sinus outcome was more severe. Also the result of independent t-test showed that there was a statistically significant difference between the two groups in the mean score of sinus outcome ($P=0.007$). The average scores of sinus outcome before and after the intervention were significantly difference ($P = 0.001$). So that the mean score of the sinus outcome after the intervention (45.98) it was lower than before the intervention (53.4). So overall after intervention, severity of outcome and complications of sinusitis in both intervention and control groups decreased. But this decline in the intervention group had more than the control group and this difference been statistically significant. **Conclusion:** apple cider vinegar may effectively improve the symptoms of rhinosinusitis. Considering the low cost of apple cider vinegar, its availability and easily to perform inhalation without special equipment; it can be recommended as a complementary supplement to routine treatments for patients with rhinosinusitis.

Keywords: apple, Vinegar, Inhalation, Rhinosinusitis, Chronic

1. INTRODUCTION

Rhinosinusitis is one of the most common causes of patient referral to a physician and it causes long-term discomfort for people. It is the fifth leading cause of antibiotic prescription (Safavi et al., 2007). Chronic bacterial rhinosinusitis is one of the most common chronic diseases that affect 12 to 17 percent of the population. In addition to local symptoms such as obstruction, nasal discharge and olfactory dysfunction it has many negative effects on patients' personal and social performance. Chronic rhinosinusitis is an infection that lasts more than 3 months and has a number of symptoms including: purulent rhinorrhea, headache, nasal obstruction, pain, pressure or fullness in the face and decreased sense of smell (Nour et al., 2006). Chronic rhinosinusitis is not a serious life threatening factor but because of its proximity to the eye and brain, it can cause serious complications. About 75% of all eye-catching infections are directly related to chronic rhinosinusitis and about 3.7% - 10% of brain abscesses are due to chronic rhinosinusitis (Amini et al., 2009; Pynnonen et al., 2013; Gleeson & Clarke, 2008; Watkinson & Clarke, 2018). Risk factors for chronic rhinosinusitis include: allergic rhinitis, asthma, nasal obstruction due to foreign bodies or tumors, immunosuppression by diseases such as a gamaglobulinemia, AIDS, chronic granulomatous diseases, structural defects such as cleft palate, functional deficiencies of the mucociliary system, such as siliary dyskinesia and cystic fibrosis, and finally gastroesophageal reflux (Sengun & Karapinar, 2005; Homood et al., 2017; Tint et al., 2016).

Common bacterial organisms which cause rhinosinusitis include: *Streptococcus pneumoniae*, *Hemophilus influenzae*, *Moraxella catarrhalis* and *Staphylococcus aureus*. The production of biofilm and superantigens by some of the above bacteria is also considered. Other theories have focused on colonized fungi and abnormal eosinophilic responses (Van Crombruggen, 2011; Stevens et al., 2015; Kucuksezer et al., 2018). In the diagnosis of chronic rhinosinusitis, signs and symptoms and endoscopy are the basics and imaging methods can confirm the diagnosis (Morris & Shusterman, 2016; Lau & Goudy, 2019). It is believed that resistance of pathogenic bacteria has a role in chronic rhinosinusitis. This resistance results from the natural tendency of these bacteria to form biofilms, which protects them from environmental and drug stress. These biofilms exacerbate the symptoms and infections by alternating release of bacteria. Topical treatments such as irrigation and inhalation can alter the treatment of chronic rhinosinusitis by affecting the formation of biofilms (Madeo & Frieri, 2013; Hayes, 2018; Fastenberg et al., 2016).

Apple cider vinegar is one of the apple products that contains a variety of flavonoids including quercetin, kaempferol, catechin, epigallocatechin, anthocyanin, cyanidin-3-glucoside, and organic acids such as acetic acid and malic acid (Brandon, 2014; Ismael, 2013; Katu, 2018). Apple vinegar in addition to organic acid, contains flavonoids, polyphenols, vitamins and minerals (Kondo et al., 2009; Naziroğlu et al., 2014). Around 5000 BC, the Babylonians used apple vinegar as preservative (Naziroğlu et al., 2014; Beheshti et al., 2012). Acetic acid is the main compound adding flavor to vinegar and has long been used as an important additive to acidify foods for preservation purposes. Acetic acid, as the main organic acid existing in vinegar, is responsible for acidity of vinegar. Acetic acid is a kind of monocarboxylic acid. It has a pungent odor and flavor. It is generally regarded as safe (GRAS) for general purpose and miscellaneous usage. According to Malicki, organic acids are considered weak acids, because their antimicrobial effect is a result of their undissociated forms (Malicki et al., 2004). They passively diffuse through the bacteria cell wall and internalizing into neutral pH, dissociating them into anions and protons. Release of the protons decreases internal pH and inhibits the bacteria (Ricke, 2003). So,

Apple cider vinegar has antibiotic, antibacterial and antifungal properties (Brandon, 2014; Ismael, 2013; Katu, 2018). Beta-carotene in apple cider vinegar has antioxidant properties. Consumption of apple vinegar improves immune response against pathogens; it also helps maintain the acid-base balance of the blood (Lau & Goudy, 2019). Apple cider vinegar is used in a wide number of health-related issues such as in cancer, cardiovascular diseases, body and joint pains, diabetes, and weight loss. Acetic acid as the major ingredient in apple cider vinegar (3–9%) performs its antimicrobial action by causing loss of cell integrity. Various studies have shown that vinegar plays an important role in preventing the growth of harmful bacteria (Vijayakumar & Wolf-Hall, 2002; Haruta et al., 2006).

The use of vinegar fumigation due to its acidic and antibacterial properties and pH regulation can be effective in the treatment of chronic rhinosinusitis. The aim of this study was to determine the effectiveness of apple cider vinegar application on improvement of symptoms and reduce complications in patients suffering from chronic rhinosinusitis.

2. METHODS

This study was a clinical trial study. Totally 100 patients with chronic rhinosinusitis divided into control and intervention groups (50 per group). Steps of research are depicted in Figure 1. Patients with chronic rhinosinusitis according to the AAO-HNS criteria were included. Patient examinations were performed as follows: evaluation of purulent secretions and redness of nasal mucosa and symptoms of fever, headache, sore throat and bad breath. The purpose of the study was explained to the patients and informed consent was obtained from all in 2018-2019. Ethical considerations and principles of the Helsinki Declaration fully adhered in this research (Ethical Code: IR.IUMS.FMD.REC.1398.168). Study cases randomly assigned into two study groups. Standard rhinosinusitis treatment performed in both groups including antibiotics, steroids and surgery. However, the intervention group were additionally treated by apple cider vinegar steam inhalation with a certain dose (in this study used apple cider vinegar contained 5% acetic acid, after dilution with pure water, its final concentration reached 1.7%). In the intervention group, patients received 5 minutes exposure to apple cider vinegar steam inhalation on daily basis for one month. For the control group only standard treatment was performed. SNOT-22 questionnaire was used to evaluate the symptoms. Scores below 17 was considered mild sinus outcome, 18 to 50 as medium, and a score above 50 was considered as severe sinus outcome (Toma & Hopkins, 2016). For grading polyposis Meltzer grading criterion was used. The collected data were entered into SPSS 20 statistical software and analyses by appropriate statistical tests (chi-square and t-test) were performed. The normality was assessed By Kolmogorov-Smirnov test. 0.05 was considered significant level in all tests.

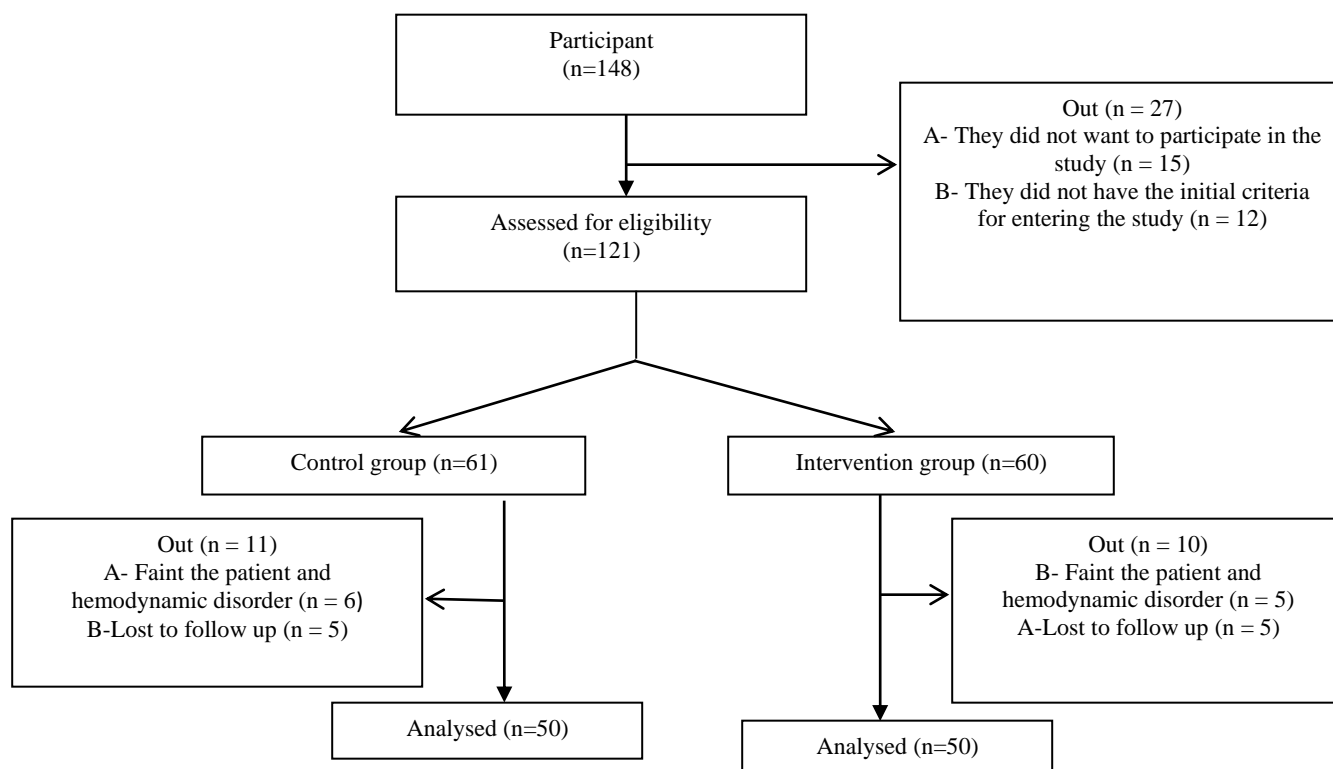


Figure 1 Consort flow chart

3. RESULTS

In this study 100 patients with chronic rhinosinusitis in the age range of 25 to 54 years with a mean age of 35.3 years were included. The results of the present study showed that there was a statistically significant difference between the two groups ($P = 0.001$). The outcome was more severe in the control group (Table 1 and Figure 2). In the independent t-test also there was a statistically significant difference between the two groups in the mean score of sinus outcome ($P = 0.007$). The mean score of sinus outcome in intervention group (43.58) was lower than the control group (48.36) (Table 2 and Figure 3). The average scores of sinus outcome before and after the intervention were significantly different ($P = 0.001$). So that the mean score of the sinus outcome after the intervention (45.98) it was lower than before the intervention (53.4) (Table 3 and Figure 4). So overall after intervention, severity of outcome and complications of sinusitis in both intervention and control groups decreased. But this decline in the intervention group had more than the control group and this difference been statistically significant.

Table 1 Comparison of rhinosinusitis outcome in two groups based on SNOT-22 questionnaire

Result	Test group		df	P-Value (Chi-square test)
	Control	Intervention		
Mild	0(0%)	0(0%)	1	0.001
medium	23(46%)	43(86%)		
Severe	27(54%)	7(14%)		

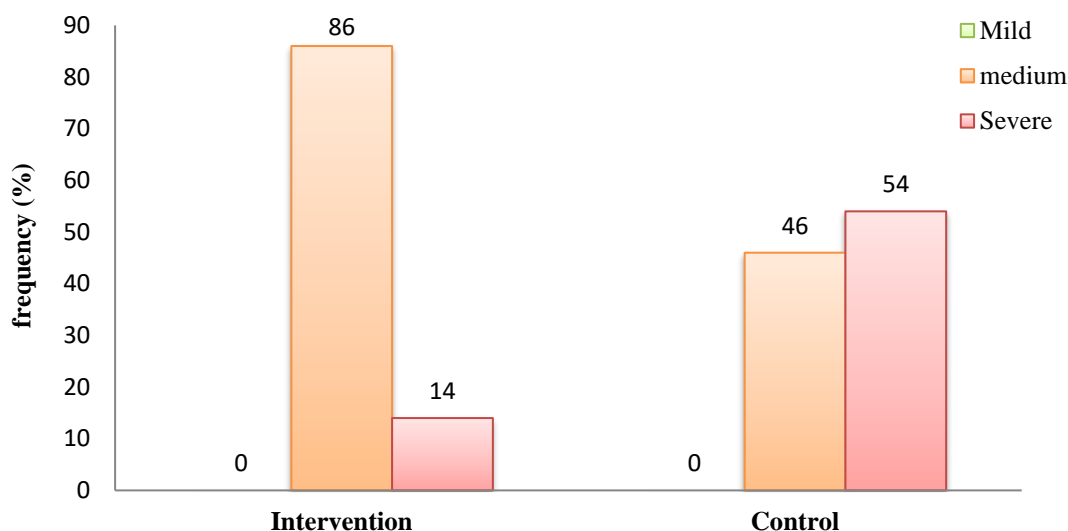


Figure 2 Frequency of rhinosinusitis outcome in two groups based on SNOT-22 questionnaire

Table 2 Comparison of mean score of SNOT-22 questionnaire (rhinosinusitis outcome) in independent t-test in two groups

Test group	Mean	Mean difference	T	P-Value
Control	48.36	4.78	2.75	0.007
Intervention	43.58			

Table 3 Comparison of mean score of SNOT-22 questionnaire (rhinosinusitis outcome) in paired t-test before and after intervention

Test group	Mean	d.f	T	P-Value
Before intervention	53.4	99	6.44	0.001
After the intervention	45.97			

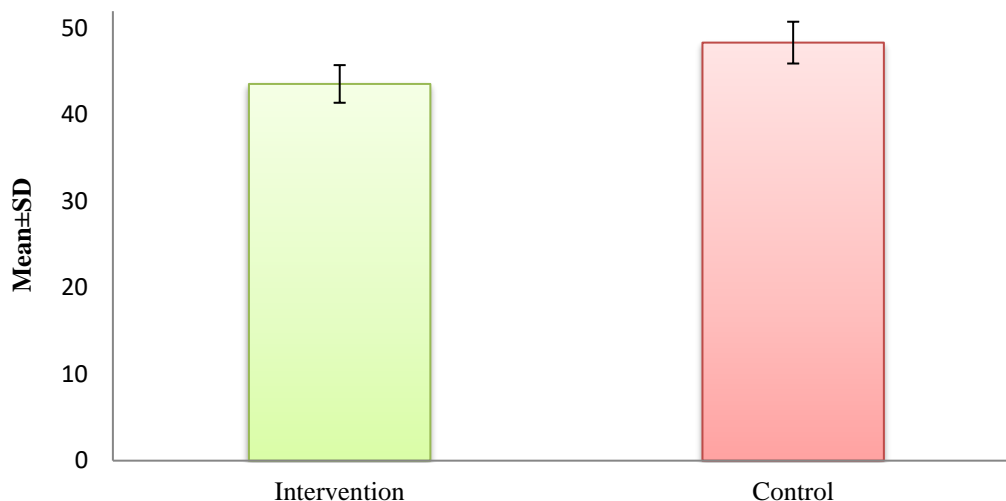


Figure 3 Mean score of SNOT-22 questionnaire (rhinosinusitis outcome) in two groups

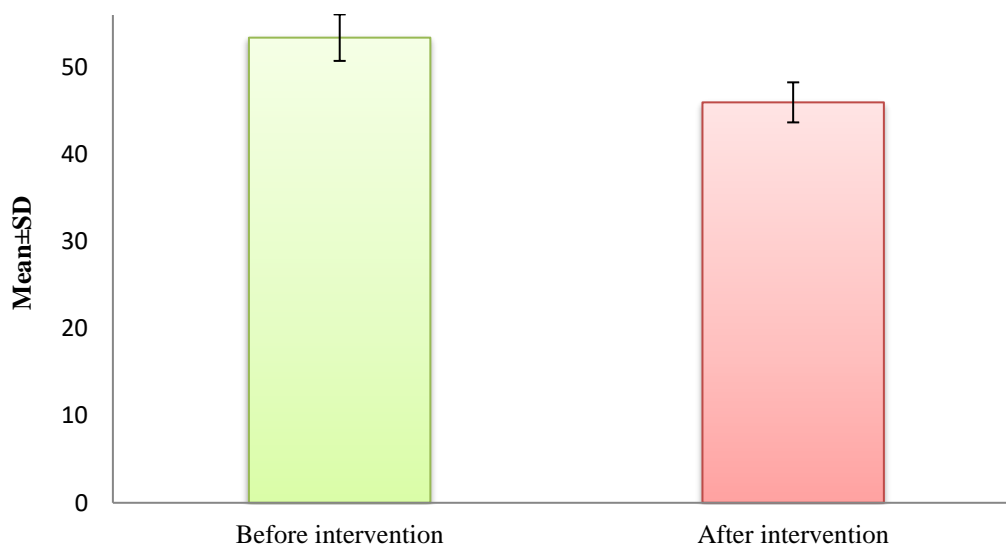


Figure 4 Mean score of SNOT-22 questionnaire (rhinosinusitis outcome) before and after intervention

4. DISCUSSION

Bacteria are naturally found in the upper respiratory tract. But when the immune system weakens or drainage of the sinuses does not happen properly, because of predisposing factors such as diseases, anatomical abnormalities, offending agents and trauma; then Bacteria trapped inside the sinuses can cause infection. If left untreated, it can lead to complications (Snow et al., 2001; Brook & Corren, 2017; Purnell & Carr, 2020). Relying solely on antibiotics to treat chronic sinus infections has many problems. Therefore, trends are focused on the use of natural sources with fewer side effects and sometimes more effectiveness. There are a bunch of studies in Iran and other parts of the world regarding the antimicrobial effect of plant extracts (Brook, 2006; Raza et al., 2019). In the present study we assessed the effect of apple cider vinegar steam inhalation in the treatment of rhinosinusitis.

Our results showed homogeneity between two groups regarding their sex and age. In the control group, the outcome and complications of rhinosinusitis were more severe. Also, the result showed that there was a statistically significant difference between the two groups in the mean score of sinus outcome ($P = 0.007$). The mean score of rhinosinusitis outcome based on SNOT-22 questionnaire in the intervention group (43.58) was lower than the control group (48.36). So, it seems that using apple cider vinegar can effectively and meaningfully reduce the complications and symptoms of rhinosinusitis. Many studies have shown the antimicrobial and antiseptic effects of apple cider vinegar. Some of these studies confirmed the antiseptic properties of apple cider

vinegar in the upper respiratory tract (Yagnik et al., 2018; Bakir et al., 2017; Saqib, 2017; Hindi, 2013; Mota et al., 2015; Baldas & Altuner, 2018). Chang and Fang investigated the antimicrobial activity of rice vinegar against *E. coli*. It was observed that there was a significant reduction in the number of pathogens (Chang & Fang, 2007). Elhan was studied the antimicrobial activities of six different vinegars against food-borne pathogens and spoilage bacteria in salads. As a result, 1 log reduction was observed, and vinegar concentration and the duration of treatment were identified to be two important parameters in decontamination (Elhan, 2014). Bornemeier et al. also tested vinegar against *S. aureus* and *L. monocytogenes*. They observed that acetic acid inhibits the growth of these two bacteria (Bornemeier et al., 1997). Lukasik et al. used 10% vinegar in strawberries inoculated with *E. coli* O157:H7, *Salmonella Montevideo*, poliovirus 1, and the bacteriophages PRD1, X174 and MS2. As a result, it was observed that vinegar reduced 90% of bacteria and about 95% of viruses (Lukasik et al., 2003). These results are in agreement with the results of the present study and show the positive effect of apple cider vinegar on the elimination of rhinosinusitis infective agents. Other natural sources also have been investigated in the treatment of rhinosinusitis. Yazdi et al. investigate the antimicrobial effect of three plants extract on microorganisms of *Streptococcus Pneumoniae*, *Hemophilus Influenza* and *Moraxella catarrhalis* which are factors of rhinosinusitis and bronchitis. The results showed that Extracts of Thyme, Eucalyptus and Myrtle were effective on bacterial growth (Yazdi et al., 2008).

5. CONCLUSION

This study revealed that Apple cider vinegar steam inhalation can be effective in improvement of symptoms and reduces complications of rhinosinusitis. It is safe and economical without producing any side effects. So considering the cheapness of apple cider vinegar and its availability and also the convenience of inhalation process, that does not require special equipment, apple cider vinegar steam inhalation can be recommended as a complementary treatment alongside routine treatments for patients with rhinosinusitis.

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Conflict of Interest:

The authors declare that they have no conflict of interest.

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