Original Article

Assessment of Nasal Congestion during Pregnancy by Acoustic Rhinometry

Girapong Ungkhara MD[1], Thanitha Borwornparus MD[2]

[1] Department of Otolaryngology, Faculty of Medicine Vajira Hospital, Navamindhradhiraj University, Bangkok, Thailand
[2] Institute of Otolaryngology, Rajavithi General Hospital, Bangkok, Thailand

Objective: To study data and characteristics of nasal congestion relating to pregnancy in each trimester.

Materials and Methods: Prospective cross sectional study was conducted. The authors study pregnant and non-pregnant women at the Department of Obstetrics and Gynaecology, Faculty of Medicine Vajra Hospital Navamindharadhiraj University. The authors use visual analog score [VAS] score and nasal obstructive score to adjust subjective symptom of nasal obstruction and using acoustic rhinometry for study objective nasal patency in pregnant and non-pregnant women.

Results: There were 109 pregnant women, first trimester 20 patients, second trimester 26 patients and third trimester 63 patients and non-pregnant women as the control group 40 women. The mean age in pregnant women is 28, 28 and 26 and in non-pregnant woman is 23 years old. Cross sectional area 1 [CSA1] significant increase in 1st, 2nd and 3rd trimester (*p*-value 0.001, 0.001 and 0.000) when compare with non-pregnant women. There was no changing in obstructive nasal symptoms score and total visual analog score [VAS] score in both groups. The average woman's pregnancy CSA1 of 1st trimester is 0.92 (range 0.14 to 1.91), CSA1 of 2nd trimester is 0.89 (0.23 to 2.25) and CSA1 of 3rd trimester is 1.0 (0.20 to 2.56).

The nasal obstructive symptom scores were 2.20 (range, 0 to 5 points) in the first trimester, averaging 1.23 in the second trimester and average 1.39 in the third trimester. VAS value of the 3 trimesters of pregnancy found that the *p*-value of a stuffy nose. (Obstruction) of 0.137 shows that no differences are statistically significant and the average VAS total was 6.05, 5.35 and 5.53 for women 1st, 2nd and 3rd trimester, respectively.

Conclusion: The authors found that the symptoms of nasal congestion decrease from the 1st trimester. In the 2nd and 3rd trimester of pregnancy the nasal congestion reduces. The causes of decreased nasal congestion during pregnancy are currently unknown.

Keywords: Nasal Congestion, Pregnancy, Acoustic rhinometry

J Med Assoc Thai 2018; 101 (Suppl. 8): S145-S151
Website: http://www.jmatonline.com

Nasal congestion during pregnancy is a common problem. A study by Bende et al questioned 2,264 pregnant women and found that in the first trimester 27 percent of them had symptoms of nasal congestion. In the second and third trimester the pregnant women had symptoms of nasal congestion of 37%, and 42% respectively[1]. Prolonged nasal congestion symptoms can affect sleep, cause daytime fatigue and headaches, and, if appropriate treatment is not received, might lead to complications such as asthma[2,3]. At present there is not enough research about the effects of nasal inflammation in pregnancy. The symptoms of nasal congestion may have a negative impact in pregnancy, such as affecting mothers' nutrition, emotional state. Nasal congestion may also cause severe snoring, leading to high blood pressure during pregnancy or an increased risk of the child retardation and decreased Apgar scores[4]. Symptoms of nasal congestion can result in worse snoring. A study of 502 pregnant women, found 10% of pregnant snorers had preeclampsia compared to 4% for pregnant non-snorers ($p<0.05$). Furthermore, they found the foetus to be more vulnerable to slower growth rates in the group of snoring pregnant women

Correspondence to:
Ungkhara G. Department Of Otolaryngology, Faculty of Medicine Vajira Hospital, Navamindhradhiraj University, Bangkok 10300, Thailand.
Phone: +66-81-6254412
E-mail: girapong@nmu.ac.th

How to cite this article: Ungkhara G, Borwornparus T. Assessment of Nasal Congestion during Pregnancy by Acoustic Rhinometry. J Med Assoc Thai 2018;101;Suppl.8: S145-S151.

when compared to the non-snoring group of pregnant women, with rates of 7.1% and 2.6%, respectively[4].

In addition, symptoms of nasal congestion during pregnancy may have other causes, such as: allergic rhinitis; rhinitis caused by the nervous system (Vasomotor Rhinitis); or rhinitis from intranasal decongestive drugs (Rhinitis Medicamentosa). Allergic symptoms often have their first onset in childbearing age and pregnant women, frequently with symptoms of allergic rhinitis. Some pregnant women avoid unnecessary oral drugs for fear of side effects. Nasal sprays may be the only treatment used, thus leading to drug-induced rhinitis.

Acoustic Rhinometry, according to Hilberg[5], is the measurement of the nasal cavity using sound waves. When sound waves are applied to the nasal cavity they are reflected back. A microphone picks up the audio signal and converts it into digital signals, and these will be displayed on computer as a line graph, showing the cross section area size (cm) and its distance from the nostril (cm)[6]. Recently Acoustic rhinometry is one of high reliable assessments of nasal congestion[7,8].

Acoustic rhinometry releases sound in the nose and measures resonating sound, and is therefore safer and not harmful to pregnant women. Current research has ensured the greater availability of acoustic rhinometry for pregnant women[9,10], with improved accuracy and sensitivity (54%), and specificity (70%)[11]. Other advantages include more rapid assessment and detection.

Evaluation involves several methods, such as taking a history plus acoustic rhinometry (the Objective test), nasal peak flowmetry or anterior rhinomanometry. It is not yet has any tool that accepts as a gold standard[6].

A study on nasal congestion symptoms during pregnancy, measured acoustic rhinometry, rhinomanometry, and used anterior mucocilliary time in pregnant women, tracking them from the first trimester until after birth[12]. But there is no comparison with non-pregnant women. This research studied nasal congestion symptoms of pregnant women in each trimester using acoustic rhinometry tools in any trimester and aimed to prevent complications that follow from the symptoms of nasal congestion during pregnancy.

Materials and Methods

The present study was approved by the Institutional Review Board [IRB]. All pregnant women joined the study were informed about the research protocol and signed consent forms before the study was started. The authors studied pregnant women who received prenatal care at pregnancy check-up at the Department of Obstetrics and Gynaecology, Faculty of Medicine Vajra Hospital, Navamindharadhiraj University. Pregnant and non-pregnant women were completed questionnaire, VAS score and assessed using acoustic rhinometry applied to the nose. Acoustic rhinometry is a non-invasive technique that measures the reflectivity of sound waves, using a maximum 146 dB for a period of 50 milliseconds. It is harmless and the recipient will feel nothing during examination. The acoustic rhinometry machine will generate sound to the nose and calculated reflected sound in computer to calibrate cross sectional area in nasal cavity. The CSA1 is cross sectional area in the nose at 1 cm from opening of anterior nose that correlated to clinical nasal obstruction. The VAS score, nasal obstructive score and acoustic rhinometry were performed by 2 otolaryngologist in our department. The data were collected between 1 January 2011 to 30 December 2011. The population included 149 women, 40 of whom were not pregnant. The mean age was 23 years (age range 18 to 39 years). Twenty women were in the first trimester, 26 in the second trimester, and 63 were in their third trimester.

Statistical analysis

Descriptive summaries were presented as frequencies and percentages for categorical variables and median/mean and ranges for continuous variables. Comparisons symptom in each trimester of pregnancy and measurement of acoustic rhinometry were done in mean different each. All of the test were two sides, and *p*-value less than 0.05 were considered as statistical significance.

Results

The data were collected between 1 January 2011 to 30 December 2011. The population included 149 women, 40 of whom were not pregnant. The mean age was 23 years (age range 18 to 39 years). Twenty women were in the first trimester, 26 in the second trimester, and 63 were in their third trimester. The average age of the pregnant women in 1st trimester was 28 years of age, pregnancy average was 10 weeks (gestational age of 5 to 13 weeks). Women in 2nd trimester had an average age of 28 years with a mean gestational age of 21 weeks (range 14 to 27 weeks of gestation). Women in the 3rd trimester group had an average age of 26

years and mean gestational age was 34 weeks (range 28 to 39 weeks of gestation). Most pregnant women with a history of smoking (3.45%)[4] were in the second trimester (3 women) and 1 in the 3rd trimester of all people with a history of smoking.

Effective evaluation of severe nasal congestion symptoms was performed using a VAS score. Pregnant women with symptoms had average value of 5 (VAS score range 0 to 14). The average VAS of nasal obstruction was 1.23 (score range 0 to 5).

The VAS scores indicating a relationship between nasal congestion and pregnancy showed no difference with those women who were not pregnant, even when a comparison was made with each trimester (*p*-values, pregnant women: 0.055, 0.988, 0.592; versus non-pregnant women, *p*-values: 0.337, 0.761, 0.536), as shown in Table 2.

Comparing the VAS of pregnant women with stuffy nose in each trimester found the following: VAS scores for pregnant women in 1st trimester was not significantly different those in 2nd trimester to (*p*-value 0.180). Furthermore, when comparing pregnant women in 1st trimester to those in VAS scores were not significantly different (*p*-value: 0.205) in pregnant women. Nor were the VAS scores for pregnant women in 2nd trimester compared to the third VAS stuffy nose significantly different (*p*-value: 0.920). Similarly, there was no difference in VAS pain scores when comparing the different groups (*p*-values: 0.873, 0.909, 0.983). See Table 3.

Acoustic rhinometry examinations of pregnant women revealed an average total volume [TV] of 3.86 (range 0.06 to 12.24). Average cross-sectional area 1 [CSA1] was 0.41 (range 0.02 to 0.83). Table 6 shows the acoustic rhinometry examinations of pregnant women The average TV in trimester 1 is 3.12 (range 0.80 to 4.81), trimester 2 is 3.85 (1.88 to 9.10), and trimester 3 is 3.92 (0.91 to 21.34). The average woman's pregnancy CSA1 in trimester 1 is 0.92 (range 0.14 to 1.91). The average woman's pregnancy CSA1 in trimester 2 is 0.89 (0.23 to 2.25). The average woman's pregnancy CSA1 in trimester 3 is 1.0 (0.20 to 2.56) as shown in Table 4.

Analysing the relationship between Acoustic rhinometry values and pregnancy, and comparing women in each trimester of pregnancy with non-pregnant women using Independent-sample t-test,

Table 1. Characteristics

	Characteristics			
	Average(range)			
	n	Age (yrs)	Gestational age. (week)	% Smoking
Control	40	23.13±3.784 (18 to 38)	-	0%
Pregnant				
1st trimester	20	28.10±5.821 (20 to 39)	10.20±2.308 (5 to 13)	0%
2nd trimester	26	28.35±5.803 (18 to 39)	21.46±4.130 (14 to 27)	11.54% (3 subjects)
3rd trimester	63	26.67±5.995 (18 to 39)	34.24±3.315 (28 to 39)	1.59% (1 subject)

Table 2. Comparison of VAS Scores between control and pregnant subjects at trimester 1, 2, 3: independent-sample t-test

Visual Analog Scale (VAS)	n		Average	*p*-value
Obstruction	40	Control	1.23±1.423	
	20	Pregnant_1st trimester	2.20±1.935	0.055
	26	Pregnant_2nd trimester	1.23±1.773	0.988
	63	Pregnant_3rd trimester	1.39±1.670	0.592
Total VAS	40	Control	5.00±4.006	
	20	Pregnant_1st trimester	6.05±3.873	0.337
	26	Pregnant_2nd trimester	5.35±5.153	0.761
	63	Pregnant_3rd trimester	5.53±4.471	0.536

* Alpha level 0.05 ($p<0.05$)

showed that the TV of pregnant women in each trimester, compared with non-pregnant women, was different (*p*-value: 0.162, 0.984, 0.893). Furthermore, the CSA1 of pregnant women in each trimester, when compared with non-pregnant women, showed the relationship was significantly different in the third trimester (*p*-value: 0.001, 0.001, 0.000) (Table 4).

Discussion

Currently, there is no clear definition of what constitutes pregnancy-induced nasal inflammation. Ellegard and Karlson[9] found nasal congestion occurs for at least 5 weeks during pregnancy without any symptoms of respiratory tract infection or allergy symptoms, and nasal congestion disappeared within 2 weeks. There are several causes for mucosal inflammation, such as increased blood flow to nasal mucosa due to increased blood volume during pregnancy, and the increased influence of the sex hormones estrogen and progesterone during pregnancy resulting in direct and indirect mimicking of nasal congestion symptoms[13]. But there are no clear conclusions as to causation. Symptoms of nasal congestion often occur in the second trimester of

Table 3. Comparison of VAS Score for pregnant women at each trimester: One-way anova test

Dependent variable	Multiple Comparisons		
	(I) Trimester	(J) Trimester	*p*-value
Obstruction			
Scheffe	1	2	0.180
		3	0.205
	2	1	0.180
		3	0.920
	3	1	0.205
		2	0.920
Total VAS			
Scheffe	1	2	0.873
		3	0.909
	2	1	0.873
		3	0.983
	3	1	0.909
		2	0.983

* Alpha level 0.05 ($p<0.05$)

Table 4. Comparison of acoustic rhinometry between control and pregnant women at trimester 1, 2, 3: independent-sample t-test

Acoustic rhinometry	n		Average	*p*-value*
TV	40	Control	3.86±2.069	
	20	Pregnant Trimester 1	3.12±1.450	0.162
	26	Pregnant Trimester 2	3.85±1.573	0.984
	63	Pregnant Trimester 3	3.92±2.457	0.893
	109	Total	3.76±2.121 (0.80 to 21.34)	
CSA1	40	Control	0.41±0.185	
	20	Pregnant Trimester 1	0.92±0.584	0.001
	26	Pregnant Trimester 2	0.89±0.653	0.001
	63	Pregnant Trimester 3	1.00±0.814	0.000
	109	Total	0.96±0.736 (0.14 to 2.56)	

* Compared with control

pregnancy and the symptoms will disappear in the first weeks after birth[14].

Philpott et al[12] studied nasal inflammation symptoms in 18 pregnant women using anterior rhinoscopy, peak inspiratory nasal flow, acoustic rhinometry, rhinomanometry and nasal symptom questionnaire. Inflammation occurs in pregnant women from the 1st trimester to the post-natal period. Anterior rhinomanometry, mucociliary clearance, rhinometry, time, and the questionnaire yielded statistical significance. Acoustic rhinometry showed the total volume value, but the results were not statistically significant.

Ellegard et al[9] studied nasal obstruction in 23 pregnant women from the 1st trimester until after birth using a questionnaire tool and measuring the maximum inhalation (nasal peak flow) results. The assessment from the questionnaire found that symptoms of nasal congestion increase during pregnancy and decrease postnatally. However, measurement by nasal peak flow found that, among 8 women, it decreases as pregnancy progresses, and found that among 9 women nasal peak flow increases when pregnant.

Demir et al[15] found no correlation in pregnant and non-pregnant nasal symptom measure by acoustic rhinometry as well but they found no different in MCA1 in both group. The authors found different from them that the pregnant women tend to decreasing in nasal resistant in 3rd trimester.

Aspiring researchers should study the severity of nasal congestion symptoms in pregnant women in each trimester of pregnancy using Acoustic rhinometry and VAS Score evaluation as they and nasal symptom score related to nasal congestion[6-8]. Summary results found that, measurement using acoustic rhinometry provides tangible results (Objective test). Total volume and value of CSA1 (cross sectional area 1) showed a decrease in this research. Researchers found that total volume differences are not the same when comparing pregnant with non-pregnant women. CSA1 showed significant increase in every trimester. Symptoms of nasal congestion decreased. Results in each trimester were no different when comparing groups of pregnant women. The study shows that it is an objective test. Symptoms of nasal congestion increase during pregnancy from the 1st trimester. When entering the 2nd and 3rd trimesters symptoms of nasal congestion continue to increase, when compared with non-pregnant women.

Total results for VAS symptoms of nasal congestion, when compared between groups of pregnant and non-pregnant women, show that results do not differ. Symptoms of nasal congestion, as measured with acoustic rhinometry, increased, but a feeling of stuffy nose and nasal symptoms among other pregnant women did not increase more compared to women who were not pregnant.

Table 5. Comparison of Acoustic rhinometry pregnant at each trimester: One-way anova test

Dependent variable	Multiple comparisons		
	(I) Trimester	(J) Trimester	*p*-value
TV			
Scheffe	1	2	0.521
		3	0.347
	2	1	0.521
		3	0.989
	3	1	0.347
		2	0.989
CSA1			
Scheffe	1	2	0.990
		3	0.907
	2	1	0.990
		3	0.801
	3	1	0.907
		2	0.801

* Alpha level 0.05 ($p<0.05$)

CSA1 values showed an increase as pregnancy progresses. CSA1 from original studies by Ellegard[9] give similar results. Nine pregnant women, from a population of 23, showed increased peak nasal flow. The decrease in symptoms of nasal congestion during pregnancy may be caused by hormonal changes during pregnancy, or neurological changes may make pregnant women adapt better. Further research should be undertaken in the future to explore this.

One of the limitations of this research includes its small number of participants. Future research should aim to increase the sample size. Stress affects the measurement of acoustic rhinometry because measurement sends sound waves through the nose and temples that is reflected back as sound waves. Additionally, noise and temperature affect the results. In this research, detection of acoustic rhinometry was done in a quiet room with the door and windows closed to prevent noise. Air conditioning was a central unit but without a temperature gauge. From this we expected a very small error in our results.

Conclusion

Evaluating symptoms of nasal congestion in pregnant women showed that acoustic rhinometry was the most objective test. The authors found that the symptoms of nasal congestion decrease from the 1st trimester. In the 2nd and 3rd trimester of pregnancy the nasal congestion reduces. The causes of decreased nasal congestion during pregnancy are currently unknown. There should be more research in future.

What is already known in this topic?

The authors have known pregnancy can lead pregnancy rhinitis that cause nasal obstruction during pregnancy.

What this study adds?

The present study show there were increase CSA1 from pregnancy 1st to 3rd Trimester lead pregnant women no symptom of nasal obstruction.

Acknowledgements

Confirmation in each trimester of pregnancy completed by Dr. Wisit Kosuwandi Department of Obstretics and Gynecology, Faculty of Medicine Vajira Hospital Navamindhradhiraj University Bangkok, Thailand.

Potential conflicts of interest

The authors declare no conflict of interest.

References

1. Bende M, Gredmark T. Nasal stuffiness during pregnancy. Laryngoscope 1999;109:1108-10.
2. Juniper EF. Measuring health-related quality of life in rhinitis. J Allergy Clin Immunol 1997;99:S742-S749.
3. Incaudo GA, Takach P. The diagnosis and treatment of allergic rhinitis during pregnancy and lactation. Immunol Allergy Clin North Am 2006;26:137-54.
4. Franklin KA, Holmgren PA, Jonsson F, Poromaa N, Stenlund H, Svanborg E. Snoring, pregnancy-induced hypertension, and growth retardation of the fetus. Chest 2000;117:137-41.
5. Hilberg O, Jackson AC, Swift DL, Pedersen OF. Acoustic rhinometry: evaluation of nasal cavity geometry by acoustic reflection. J Appl Physiol (1985) 1989;66:295-303.
6. Zeiders J, Pallanch JF, McCaffrey TV. Evaluation of nasal breathing function with objective airway testing. In: Cummings CW, Haughey BH, Thomas JR, editors. Cummings otolaryngology: Head & neck surgery. Vol. 2. 4th ed. Philadelphia: Elsevier Mosby; 2005. p. 898-933.
7. Kjaergaard T, Cvancarova M, Steinsvag SK. Does nasal obstruction mean that the nose is obstructed? Laryngoscope 2008;118:1476-81.
8. Mamikoglu B, Houser SM, Corey JP. An interpretation method for objective assessment of nasal congestion with acoustic rhinometry. Laryngoscope 2002;112:926-9.
9. Ellegard E, Karlsson G. Nasal congestion during pregnancy. Clin Otolaryngol Allied Sci 1999;24:307-11.
10. Corey JP, Gungor A, Nelson RH, Velde T. The effects of environmental noise on acoustic rhinometry. Am J Rhinol 1996;10:247-49.
11. Mamikoglu B, Houser S, Akbar I, Ng B, Corey JP. Acoustic rhinometry and computed tomography scans for the diagnosis of nasal septal deviation, with clinical correlation. Otolaryngol Head Neck Surg 2000;123:61-8.
12. Philpott CM, Conboy P, Al Azzawi F, Murty G. Nasal physiological changes during pregnancy. Clin Otolaryngol Allied Sci 2004;29:343-51.
13. Lekas MD. Rhinitis during pregnancy and rhinitis medicamentosa. Otolaryngol Head Neck Surg 1992;107:845-8.
14. Blaiss MS. Management of rhinitis and asthma in pregnancy. Ann Allergy Asthma Immunol 2003;90:16-22.

15. Demir UL, Demir BC, Oztosun E, Uyaniklar OO, Ocakoglu G. The effects of pregnancy on nasal physiology. Int Forum Allergy Rhinol 2015;5:162-6.