Original Article / Çalışma - Araştırma

Assessment of nasal airway patency during pregnancy and postpartum period: correlation between subjective and objective techniques

Gebelik sırasında ve postpartum dönemde nazal hava yolu açıklığının değerlendirilmesi

Mehmet Karataş, MD.,[1] Osman Halit Çam, MD.,[2] Muhammet Tekin, MD.[3]

[1]*Department of Otolaryngology, Medical Faculty of Adıyaman University, Adıyaman, Turkey*
[2]*Department of Otolaryngology, International Bosphorus ENT, İstanbul, Turkey*
[3]*Department of Otolaryngology, Medical Faculty of İstanbul Medeniyet University, İstanbul, Turkey*

ABSTRACT

Objectives: This study aims to determine the physiological changes in a pregnant woman's nasal airway, the frequency of pregnancy rhinitis, and the correlation among anterior rhinoscopy (AnR), anterior rhinomanometry (ARM), and subjective nasal obstruction score as she progresses through pregnancy into the postpartum period (PPP).

Patients and Methods: Twenty non-smoking healthy pregnant women aged 19-35 (average 27.5±4.7) without a history of either respiratory allergy or chronic nasal or sinus problems were included in the study. Detailed history taking, AnR, and ARM were performed by the same ear nose and throat specialist at each trimester and postpartum second week. From then on, the participants scored, subjectively, morning levels of nasal obstruction (0= none, 1= slight, 2= moderate, 3= severe, 4= total obstruction).

Results: The AnR scores were low and the ARM findings were in normal range in the first trimester. Increasing AnR scores through pregnancy and decreasing AnR scores at PPP were statistically significant. Similarly, the ARM findings increased through pregnancy and decreased to normal levels at PPP; however, these changes among trimesters and PPP were not statistically significant.

Conclusion: Anterior rhinomanometry and AnR are useful tools in the determination of nasal physiological changes as pregnancy progresses to PPP.

Keywords: Anterior rhinoscopy; objective/subjective technique; pregnancy rhinitis; rhinomanometry.

ÖZ

Amaç: Bu çalışmada gebeliği postpartum döneme (PPD) doğru ilerleyen bir kadının nazal hava yolundaki fizyolojik değişiklikler, gebelik rinitinin sıklığı ve anterior rinoskopi (AnR), anterior rinomanometri (ARM) ve subjektif burun tıkanıklığı skoru arasındaki ilişki belirlendi.

Hastalar ve Yöntemler: Yaşları 19-35 (ortalama 27.5±4.7) olan, sigara içmeyen, respiratuvar alerjisi veya kronik nazal ya da sinüs problemleri olmayan 20 sağlıklı gebe kadın çalışmaya dahil edildi. Her trimesterde ve postpartum ikinci haftada aynı kulak burun ve boğaz uzmanı tarafından detaylı öykü alımı, AnR ve ARM uygulandı. Sonrasında, katılımcılar burun tıkanıklığının sabahki düzeylerini subjektif olarak puanladı (0= yok, 1= az, 2= orta, 3= şiddetli, 4= tam tıkalı).

Bulgular: Birinci trimesterde AnR skorları düşük ve ARM bulguları normal aralıkta idi. Gebelik boyunca artan AnR skorları ve PPD'de azalan AnR skorları istatistiksel olarak anlamlıydı. Benzer şekilde, ARM bulguları gebelik boyunca arttı ve PPD'de normal düzeylere azaldı; ancak, trimesterler ve PPD arasındaki bu değişiklikler istatistiksel olarak anlamlı değildi.

Sonuç: Gebelik PPD'ye doğru ilerledikçe nazal fizyolojik değişikliklerin belirlenmesinde ARM ve AnR faydalı araçlardır.

Anahtar Sözcükler: Anterior rinoskopi; objektif/subjektif teknik; gebelik riniti; rinomanometri.

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Correspondence / İletişim adresi: Mehmet Karataş, MD. Cumhuriyet Mah., 25122. Sok., No: 1B/5, 02040 Adıyaman, Turkey.
Tel: +90 416 - 223 14 22 e-mail *(e-posta):* mehmetkaratas78@gmail.com

Although pregnancy related nasal congestion has been a common problem for years, it has only recently been defined as pregnancy rhinitis (PR). In an attempt to define PR, Ellegård and Karlsson[1] recorded nasal congestion scores and expiratory peak flow daily in 23 pregnant women until one month postpartum. They found that congestion was greater during pregnancy compared to the postpartum period (PPP). They then defined PR as "nasal congestion in the last six or more weeks of pregnancy without other signs of respiratory tract infection and with no known allergic cause, disappearing completely within two weeks after delivery."

The prevalence of PR ranges from 8%[2] to 32%[3] and appears to be rather harmless compared to preeclampsia, the most frequent cause of maternal and fetal morbidity and mortality. However, it is of clinical significance due to the potential relationship between PR and preeclampsia.

The relationship between PR and preeclampsia lies in snoring. Although snoring is rather common during pregnancy, it can also be associated with maternal hypertension, preeclampsia, intrauterine growth retardation and low Apgar score.[4] Nasal congestion is aggravated particularly in supine position and leads to snoring in patients with rhinits.[5]

Several articles suggesting a relationship between the female genital organs and nose were published in the late 19th century. In 1881, it was reported in a case report that symptoms of a woman with ozena were increased during the menstrual period.[6] In 1884, Mac Kenzie[7] published a series of studies suggesting that menstruation led to erection of the nasal concha and menstruation or sexual stimuli led to worsening of nasal symptoms. He further expanded his theories in 1898 and hypothesized that nasal congestion occurred during pregnancy.[8] Moreover, in 1892, Endriss[9] described that epistaxis occurred and nasal disease was aggravated during the menstrual period.

In 1943, Mohun[10] reported a case series of 20 pregnant women with vasomotor rhinitis. Nasal symptoms were observed between three and seven months of pregnancy and continued until delivery in these patients. Symptoms had disappeared in all but one patient until 10 days postpartum. Mohun[10] concluded that this condition was associated with estrogen status and pregnancy acromegaly led to the development of vasomotor rhinitis in nasal structures. Later studies have confirmed the effects of estrogen on nasal mucosa and nasal estrogen treatment has been shown to be beneficial in cases of atrophic rhinitis.[11,12]

It has been reported that hypertension, independent of body mass index, was responsible from regular snoring in 9% of 73,231 non-pregnant women.[13] In a survey study conducted on 502 women at postpartum day 1, 23% of the women reported regular snoring during the last week of their pregnancy. It was also noted that hypertension, preeclampsia, and intrauterine growth retardation were significantly higher and Apgar scores of the babies were significantly lower in these women.[2]

Most of the inspired nitric oxide (NO) is produced in the maxillary sinus and it increases pulmonary oxygenation by reducing pulmonary vascular resistance.[14] Mouth breathing caused by PR reduces NO inhalation and subsequently affects pulmonary vascular tonus or oxygenation. As a result, oxygenation of the fetus is also impaired.

Pregnancy rhinitis can also become problematic in individuals who can normally breathe from their nose but are susceptible to obstructive sleep apnea (OSA). Hypertension characterized by an increase in nocturnal blood pressure, reported to be related to snoring and OSA, is associated with preeclampsia.[2]

The aims of the study were to determine the nasal patency throughout pregnancy and PPP with the help of objective and subjective methods; anterior rhinomanometry (ARM) versus anterior rhinoscopy (AnR) and subjective nasal obstruction scores (SNOS) respectively, to asses the correlation between these methods and to identify the frequency of PR.

PATIENTS AND METHODS

The present prospective study was conducted in the Departments of Otolaryngology and Obstetrics and Gynecology of Göztepe Training and Research Hospital between October 2008 and June 2009. Thirty pregnant women aged between 19-35 years admitting to the pregnancy outpatient clinic in their first trimester (T_1) were considered for inclusion in the study. Excluded were those who were smoking, had history of

allergic rhinitis, had findings of an acute upper respiratory infection other than nasal congestion, and those with chronic nasal or sinus problems. Ten women dropped out due to several reasons (abortus, failure to come for follow-up visits, etc.) and the study was completed by 20 subjects (mean age 27.50±4.66 years; range: 19-35 years). Written informed consent was obtained from all subjects. The Göztepe Training and Research Hospital Ethical Board approved the study in accordance with the Declaration of Helsinki and 'Operational Guidelines for Ethics Committees that Review Biomedical Research' handbook published by World Health Organization in 2000 and in accordance with the statements of the Republic of Turkey Drug and Pharmaceutics General Management and Good Clinical Practice (approval no: 51/I at 21.10.2008).

All subjects were evaluated four times by the same physician in all three trimesters and in the PPP. A detailed history was taken and otolaryngological examination was performed. Then, active ARM was performed in all subjects without using any decongestants. All these examinations and tests were performed between 7 and 15 weeks of the T_1, between 20 and 23 weeks of the second trimester (T_2), between 27 and 40 weeks of the third trimester (T_3), and in the postpartum two weeks or later.

All subjects were asked to rate their level of nasal obstruction according to SNOS (0= none, 1= slight, 2= moderate, 3= severe, 4= total obstruction). At the first visit, all subjects were questioned regarding the presence of PR in the T_1 for nulliparous subjects and regarding the presence of PR in the previous and current pregnancies for multiparous subjects. All subjects were questioned again during all trimesters in terms of PR until the last visit. In the PPP, the subjects were additionally questioned about the infant's gender and pregnancy duration and whether their nasal obstruction was increased, decreased or unchanged after their pregnancy.

Complete head-and-neck and otolaryngological examinations were performed in all subjects in all three trimesters. Nasal examination was performed using a nasal speculum and a head mirror. In inconclusive cases, AnR was also performed using Karl Storz 0, 30 and 90 degree endoscopes (KARL STORZ Endoscopy-America, Inc., El Segundo, CA, USA). Anterior rhinoscopy results in the nasal cavity were scored in terms of the presence of hypertrophy for both lower and middle concha (absent-0 and present-1) and the presence of mucosal congestion (mild-1 and severe-2). Maximum score on AnR was therefore six points.

Anterior rhinomanometry without decongestants was performed in all subjects after each examination using Rhinostream SRE 2000 rhinomanometry device (Interacoustics A/S, Assens, Denmark). After the mask closing both the mouth and nose was placed, the pressure probe was placed in one nostril and the nasal flow probe was placed in the other nostril. During the probe placement procedure, it was made sure that there was no deformation in the nostrils and no air leak. The subjects were asked to breathe through their nose while keeping their mouths closed. The results were measured at 150 Pa pressure. Nasal resistance following expiration and inspiration were recorded as Pa/cm^3. Resistance of each nostril was evaluated and then total inspiratory nasal resistance was calculated. Before the ARM procedure, all subjects performed nasal cleansing and rested for 20 minutes in a room with moderate sunlight at a temperature of 20±3 °C and 50% humidity. They were asked not to perform any exercise, consume any tea or coffee, two hours prior to the ARM procedure. All subjects were informed about the procedure before ARM.

Statistical analysis of the study was performed using NCSS-2007/PASS-2008 for windows (Utah, USA). In addition to descriptive statistical methods (mean, standard deviation, frequency), quantitative variables with non-normal distribution were compared between the groups using Mann-Whitney U test. ARM, AnR and SNOS results obtained at each study visits were compared using Friedman test and the group which led to significant difference was detected using Wilcoxon signed rank test. Comparison of qualitative variables was performed by using chi-square test, Fisher's exact chi-square test, Cochran's Q test and Mc Nemar test. Spearman's correlation analysis was performed to evaluate the relationship between study parameters. The results were evaluated within 95% confidence interval and $p<0.05$ was accepted as significant.

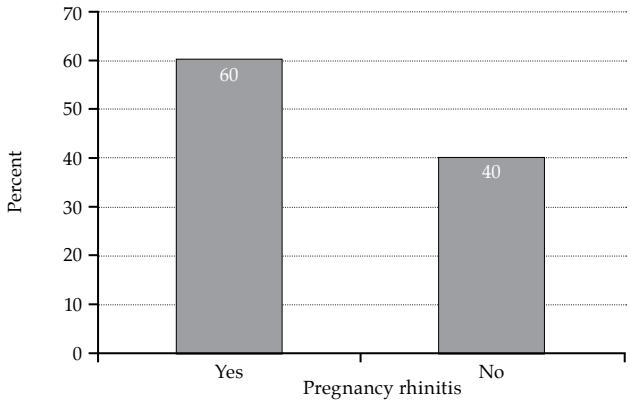

Figure 1. *The distribution of pregnancy rhinitis.*

RESULTS

Thirteen subjects (65%) were between 19-29 years of age while seven (35%) were over 30 years of age.

Pregnancy rhinitis was observed in 12 subjects (60%)-- noted only in the T_2 in two (16.7%) women, only in the T_3 in seven (58.3%) women, and in both T_2 and T_3S in three (25%) women (Figure 1).

While nasal obstruction was increased throughout the pregnancy in 14 subjects (70%), it did not change in six (30%) women. Thirteen subjects were multiparous (65%) and seven (35%) were nulliparous. Of 13 multiparous women, four (30.8%) were noted to have PR during their previous pregnancies.

Full-term pregnancy was defined as between 37 and 42 weeks and preterm pregnancy was defined as <37 weeks. Five infants (25%) were delivered preterm while 15 (75%) were delivered at term. Nine were boys (45%) and 11 (55%) were girls.

According to T_1 results, a significant positive correlation of 57.3% was noted between the ARM and AnR ($p<0.01$). However, there were no significant relationships between ARM results and SNOS ($p>0.05$) or between AnR results and SNOS ($p>0.05$). Moreover, no significant relationships were noted either between ARM and AnR results ($p>0.05$), ARM results and SNOS ($p>0.05$), or AnR results and SNOS ($p>0.05$) in the both T_2 and T_3. There were no significant relationships either between ARM and AnR results ($p>0.05$) or AnR results and SNOS ($p>0.05$) in the PPP. However, a significant positive correlation of 54.3% was noted between the ARM results and SNOSs in the PPP ($p<0.05$) (Table 1).

There was no significant relationship between the presence of PR in the previous pregnancies and the presence of PR in the current pregnancy ($p>0.05$). Moreover, no significant relationship was noted between multiparous and nulliparous women in terms of the presence of PR in the

Table 1. The relationships of anterior rhinomanometry, among anterior rhinoscopy and subjective nasal obstruction score at each visit

	r	*p*
T_1		
Anterior rhinomanometry - among anterior rhinoscopy	0.573	0.008*
Anterior rhinomanometry - subjective nasal obstruction score	0.267	0.256
Among anterior rhinoscopy - subjective nasal obstruction score	0.266	0.257
T_2		
Anterior rhinomanometry - among anterior rhinoscopy	–0.060	0.801
Anterior rhinomanometry - subjective nasal obstruction score	–0.227	0.336
Among anterior rhinoscopy - subjective nasal obstruction score	0.000	1.000
T_3		
Anterior rhinomanometry - among anterior rhinoscopy	0.042	0.859
Anterior rhinomanometry - subjective nasal obstruction score	0.253	0.281
Among anterior rhinoscopy - subjective nasal obstruction score	0.172	0.469
Postpartum period		
Anterior rhinomanometry - among anterior rhinoscopy	0.392	0.087
Anterior rhinomanometry - subjective nasal obstruction score	0.543	0.013**
Among anterior rhinoscopy - subjective nasal obstruction score	0.073	0.759

r: Spearman's Rho test; * $p<0.01$; ** $p<0.05$.

Table 2. The relationships of current pregnancy rhinitis with parity, age, prematurity and sex

	Presence of current pregnancy rhinitis				
	Yes		No		
	n	%	n	%	*p*
Parity					
Multipara	7	53.8	6	46.2	0.642
Nulliparous	5	71.4	2	28.6	
Age (years)					
19-29	9	69.2	4	30.0	0.356
≥30	3	42.9	4	57.1	
Prematurity					
Yes	4	80.0	1	20.0	0.603
No	8	53.3	7	46.7	
Sex					
Male	6	66.7	3	33.3	0.670
Female	6	54.5	5	45.5	

Fisher's exact was performed.

current pregnancy (p>0.05). Pregnancy rhinitis was noted in 53.8% of multiparous women and 71.4% of the nulliparous women.

No significant relationship was obtained between mother's age and the presence of PR in the current pregnancy (p>0.05). Pregnancy rhinitis was noted in 69.2% of the women aged between 19 and 29 years and in 42.9% of the women aged ≥30 years.

There was no significant relationship between preterm delivery and the presence of PR in the current pregnancy (p>0.05). Pregnancy rhinitis was noted in 80% of the preterm pregnancies and 53.3% of term pregnancies.

No significant relationship was detected between the infant's gender and the presence of PR in the current pregnancy (p>0.05). Pregnancy rhinitis was noted in 66.7% of male births and 54.5% of female births (Table 2).

There were no significant differences between the subjects that developed PR and the subjects without PR in terms of ARM and AnR results in the T_3 (p>0.05 for each). Moreover, no significant difference was noted between ARM results of the subjects obtained in all trimesters and PPP (p>0.05). While ARM results were within the normal limits in 50% of the subjects in the T_1, this rate was 35% in the T_2, 30% in the T_3, and 60% in the PPP (Figure 2).

A significant difference was detected between the AnR results obtained in all trimesters and PPP (p<0.01). Compared to the AnR results in the T_1, there were significant increases in the results in the T_2 (p<0.05) and T_3 (p<0.01); however, no significant change was observed in the PPP (p>0.05). Compared to the AnR results in the T_2, a significant increase was observed in the T_3 (p<0.05). On the other hand, there were significant reductions in the AnR results in the PPP compared to both those in T_2 (p<0.01) and T_3 (p<0.01) (Figure 3).

There was a significant difference between the SNOSs of the subjects obtained in all trimesters and PPP (p<0.01). A significant increase was observed in the SNOSs in the T_3 compared to those in T_1 and T_2 (p<0.05). There was a significant reduction in the SNOSs in the PPP compared to those in T_3 (p<0.05). However, no significant difference was noted between the SNOSs in T_3 and those in the T_1 and T_2 (p>0.05) (Figure 4).

DISCUSSION

In the present study, the changes in nasal physiology of pregnant women were investigated

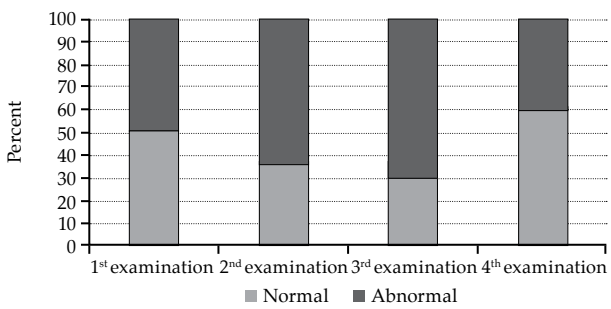

Figure 2. *Distribution of anterior rhinomanometry results according to the study visits.*

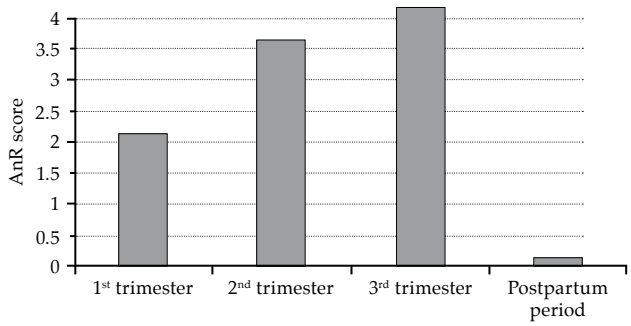

Figure 3. *Distribution of among anterior rhinoscopy results according to the study visit.*

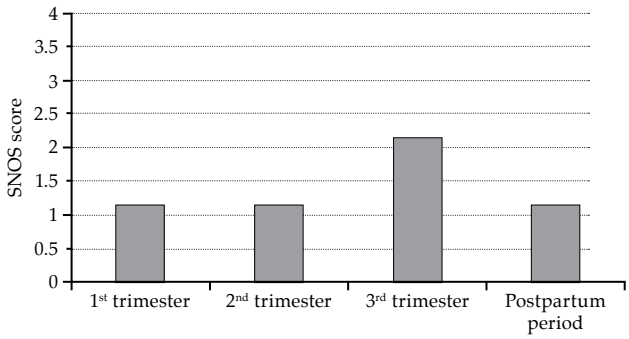

Figure 4. *Distribution of subjective nasal obstruction scores according to the study visits.*

using AnR, SNOS and ARM and the relationship between these measures was evaluated. Moreover, the prevalence of PR, its frequency in different trimesters, the effect of parity on PR, the effects of PR on preterm delivery, and the presence of PR in previous pregnancies and its relationship with current PR were also investigated.

Despite some controversy, most authors have suggested that nasal changes occurring in pregnant women are caused by female sex hormones in addition to other etiological factors including infection, stress, allergy, and rebound rhinitis. Sex hormones are likely to produce these effects through histaminergic receptors by increasing histamine 1 (H1) receptor expression in nasal epithelial and microvascular endothelial cells.[15] Estrogenic angioedema was first defined in an experimental study in 1936.[16] Recent studies on cytokines have suggested that interleukins may play a significant role in nasal physiological changes occurring during pregnancy.[17,18]

Serum estrogen and progesterone concentrations progressively increase during pregnancy. Thus, if female sex hormones have a positive effect on nasal mucosa as emphasized in the previous studies, an increase in nasal congestion is expected as time of delivery becomes closer.[3,19] In 2001, Bowser and Riederer[20] reported that nasal mucosa fibroblasts and subsequently the extracellular matrix of pregnant women was affected by progesterone. Moreover, they also suggested that estrogen and progesterone led to nasal obstruction in pregnant women by affecting the concentrations of neurotransmitters such as substance-P. Vasoactive intestinal peptide has also been suggested as a contributing factor in PR, but there has been insufficient evidence supporting this hypothesis.[21] Other hormonal mechanisms of action have also been reported such as elevated levels of placental growth hormone in pregnant women with PR described by Ellegård et al.,[22] and as well as cholinergic effects of estrogens.[23,24] Other suggested mechanisms include pooling of blood in venous sinusoids and reduced alpha adrenergic nerve transmission.[1]

The histological changes even in asymptomatic pregnant women are glandular hyperactivity, increased phagocytic activity, and increased mucopolysaccharides in submucosal ground substance.[25] These findings are also observed in asymptomatic women using hormonal contraceptives. In addition to these findings, squamous metaplasia and interepithelial edema in the nasal mucosa as well as hyperplasia, histiocytic proliferation and fibrous tissue accumulation in tunical glands have also been noted in symptomatic women using hormonal contraceptives.[25] All of these changes have been considered to be estrogen related and resemble histological changes occurring in chronic hypertrophy secondary to allergic rhinitis. Mabry[23] suggested that estrogen was not the sole responsible factor from nasal congestion and stated that emotional factors had a significant role in perception of nasal symptoms.

In the present study, nasal physiological changes were assessed by ARM, AnR and SNOS. Alternative methods that are used to assess the changes include acoustic rhinometry, peak inspiratory nasal flow rate, saccharin test for nasal mucociliary clearance, rhinitis quality of life questionnaire, and olfactory threshold test.[26,27]

The first quantitative study on nasal airway changes during pregnancy was performed by Derkay in 1988.[28] In that particular study, ARM results were compared in 20 pregnant women with Eustachian tube dysfunction (ETD)--(symptomatic group), 20 pregnant women without ETD (asymptomatic group) and 20 age-matched non-pregnant women (control group). While total nasal inspiratory resistance (TNIR) values of the symptomatic group were found to be significantly different from the other two groups ($p<0.05$), those of the asymptomatic group were in between the other two groups. The author concluded that the nasal passage

was reduced in symptomatic pregnant women. However, the difference between the trimesters was not taken into account in that particular study. Philpott et al.[26] conducted their study on 18 pregnant women and found that there was a decrease in TNIR instead of an increase from the T_1 towards the T_3. In the present study, the mean TNIR value was within the normal range in all subjects in the T_1, increased in T_2 and T_3S and returned to normal in the PPP. Although there was no significant difference in ARM results between the study visits ($p>0.05$), the increases in TNIR values in the T_2 and T_3 were noteworthy.

In a study using AnR, significant differences were reported between the AnR results in all three trimesters and PPP.[26] In the current study, a significant difference was also noted between the AnR results in all three trimesters and PPP ($p<0.01$). There was a significant increase in the AnR results in T_2 ($p<0.05$) and T_3 ($p<0.01$) compared to those in the T_1 while no significant difference was found between the postpartum and T_1 AnR results ($p>0.05$). The T_3 AnR results were significantly higher ($p<0.05$) and the postpartum AnR results were significantly lower compared to those in T_2 ($p<0.01$). The postpartum AnR results were also significantly lower than T_3 AnR results ($p<0.01$). We therefore concluded that clinically significant changes occurred in the nasal cavity during pregnancy.

In a study involving 23 pregnant women, Ellegård and Karlsson[1] reported that SNOSs were similar in early and late pregnancy, but significantly reduced following delivery. In the present study, a significant difference was obtained between the SNOSs in all study visits ($p<0.01$). The T_3 SNOSs were significantly higher than those in the T_1 and T_2 ($p<0.05$) and the postpartum SNOS was significantly lower than that of in the T_3 ($p<0.05$). Therefore, we concluded that there might be an increase in subjective symptoms as the pregnancy progressed.

In the current study, there was a significant positive correlation of 57.3% between the T_1 ARM and AnR results ($p<0.01$). There was also a significant positive correlation of 54.3% between ARM results and SNOSs ($p<0.05$). Although there was a significant correlation between AnR and SNOS during progression of pregnancy, no significant difference was noted for ARM. Statistically significant correlations were also noted between the T_1 ARM and AnR results and between the postpartum ARM results and SNOSs.

In the literature, the incidence of PR ranges from 8% to 32%.[2,3] Ellegård and Karlsson[1] found that nasal obstruction symptoms were increased in 35% of women, decreased in 39% of women, and did not change in 26% of women as the pregnancy progressed. However, nasal obstruction was increased in 80% and decreased in 20% of those with PR, and increased in 22%, decreased in 44%, and unchanged in 34% of those without PR. In the another study performed by Tüz et al.[29] the incidence of PR was 40%. On the other hand, in the present study, the incidence of PR was 60%, which was higher than reported in other studies. When nasal obstruction was evaluated, it was found to be increased in 90% (11/12) and unchanged in 10% (1/12) of those with PR; however, it increased in 37% (3/8) and unchanged in 63% (5/8) of those without PR. Furthermore, the increase ($p>0.05$) in nasal obstruction as the pregnancy progressed was significant and in parallel with previous reports.

In a study involving 82 pregnant women of whom 40 were multiparous, multiparity was not found to have a significant effect on PR.[30] In contrast, Löth and Bende[31] suggested that multiparity had an effect on PR. Similarly, Philpott et al.[26] also reported that multiparity had an effect on PR. On the other hand, no significant relationship was found between multiparity or nulliparity and the presence of PR in the current study ($p>0.05$). Moreover, premature delivery was also not found to be associated with PR. Furthermore, the presence of PR in previous pregnancies was not associated with the presence of PR in the current pregnancy.

Correlations between subjective and objective methods have also been investigated. In a study involving 250 volunteers, Jones et al.[32] did not find an association between the subjective sensation of nasal obstruction and ARM. Gungor et al.[33] did not find correlations between visual analog scale and acoustic rhinometry during the nasal cycle. In other studies, the subjective nature of nasal obstruction correlates better with measurements of ARM than with acoustic rhinometry.[34,35] Yepes-Nuñez et al.[36] compared objective and subjective methods. They found

that there were moderate to strong correlation between objective ones, moderate correlation between subjective ones and weak or absent correlation between the subjective and objective ones. They concluded that each of the techniques assess different aspects of nasal obstruction making them complementary. In our study, although increase in SNOSs and AnR results in parallel with pregnancy progression and significant reduction in them in the PPP were significant there were weak correlations between subjective techniques but no meaningful correlation between subjective and objective techniques.

Risk factors associated with PR include smoking, allergy, and nasal hyperreactivity.[30] Pregnant women should be informed about PR during their first visit to the gynecologist in order to reduce its negative effects[37] and performing physical activity should be recommended for them to benefit from its decongestant effects on nasal mucosa.[38] Sato[39] studied the treatment of allergic rhinitis during pregnancy and concluded that inhaled corticosteroids, antihistamines, leukotriene receptor antagonists, nasal decongestant sprays, intranasal cromolyn, and immunotherapy have not been associated with increased incidences of human malformations. However, the long-term physical, psychological, and developmental effects on children have not been well studied. Inhaled corticosteroids are recommended as a first-line therapy during pregnancy because of their therapeutic effectiveness, low absorption into the maternal circulation, lack of reported adverse effects, and long marketing history.[39] Surgical intervention can also be recommended in patients with OSA who are unable to tolerate continuous positive airway pressure.

In conclusion, changes in nasal physiology occur as the pregnancy progresses due to factors such as estrogen, progesterone, placental growth factor, neuropeptides, infection, and stress and may lead to significant deterioration in the quality of life of the pregnant women. In the present study, pregnancy associated nasal airway changes were evaluated by objective and subjective methods, ARM versus AnR and SNOS respectively.

In our study although increase in SNOSs and AnR results in parallel with pregnancy progression and significant reduction in them in the PPP were significant there were weak correlations between subjective techniques but no meaningful correlation between subjective and objective techniques.

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