Original Article

Color doppler study of occupational tobacco exposure effects on fetoplacental circulation among pregnant bidi workers and pregnant non bidi workers

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Abstract

Background: While preparing bidies by pregnant women, ingredients of tobacco are likely to be absorbed through intact skin of the hands and inhaled as fine dust. Doppler ultrasound, a new noninvasive technique is used to assess the qualitative aspects of uteroplacental circulation. In this study we have tried to study fetoplacental circulation in pregnant bidi workers and compared with pregnant non bidi workers. **Material and Methods:** The study population comprises two equal groups of 100 women each with singleton pregnancies of bidi worker and non-bidi workers at 37-38 weeks gestational age. Color Doppler and pulsed Doppler velocimetry (L and T Company) was carried out to assess Resistance index, Amniotic fluid index and umbilical artery to study fetoplacental circulation. **Results:** Pregnant bidi workers have higher uterine artery RI as compared to pregnant non bidi workers. Doppler velocimetry of the uterine arteries reflects vascular impedance on the maternal side of the placental circulation. Pregnant bidi workers have higher umbilical artery S/D ratio as compared to pregnant non bidi workers. **Discussion:** In placental insufficiency, the resistance to blood flow increases in the placental vessels, which is reflected in the umbilical artery Doppler as increased S/D ratio, RI and PI.Color Doppler is useful in studying adverse effects of tobacco handling in bidi workers on fetoplacental circulation. Pregnant bidi workers should get dietary allowance and paid leave and measures such as gloves and masks to prevent tobacco exposure.

Key Words: Color Doppler study, tobacco exposure, pregnant, fetoplacental circulation.

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INTRODUCTION

Majority of the people from developing countries like India have their socio-economic status below average, compelling the women to be one of the earning member. As majority of them are illiterate they take up jobs such as doing household works, labour, farming and some support their family by working in small industries. Smoking during pregnancy is associated with increased pregnancy complications such as decreased birth weight, increased perinatal morbidity and mortality. In South East Asia smoking among women may be rare but use of smokeless tobacco is common. One of the forms of smokeless tobacco exposure is tobacco handling while preparing bidis. The tobacco in this form will be inhaled as dust and then absorbed or it may be absorbed through intact skin. However, very few studies have been done so far to see the effects of tobacco handling in pregnant workers employed in bidi industries. In India, there are a large number of bidi industries spread across the length and breadth of the country. There are 119 small and large bidi industries in the city of Solapur, where this study was done. Around 65,000 women are employed in these

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industries. Majority of these women belong to low socioeconomic status which compels them to work and earn money to supplement their family income. While preparing bidis, ingredients of tobacco is likely to be absorbed through intact skin of the hands and inhaled as fine dust. In the mother's womb, the fetus is dependent on the nutrition supplied by mother that is on uteroplacental circulation. The placenta links the mother and fetus by indirect interaction with the maternal blood that spurts out of the uteroplacental vessels. This blood bathes the outer syncytiotrophoblast, allowing exchange of gases and nutrients with fetal capillary blood within the connective tissue at the villous core[1,2]. Information about the uteroplacental circulation and its regulation is limited by its inaccessibility to study. The previous methods of assessment have been invasive and involves use of radioactive material. Doppler ultrasound is a new noninvasive technique to assess the qualitative aspects of uteroplacental circulation[3]. In this study we have tried to study fetoplacental circulation in pregnant bidi workers and compared with pregnant non bidi workers. It is a comparative study to see whether pregnant bidi workers have significant changes in fetoplacental circulation reflected in color Doppler.

MATERIAL AND METHODS

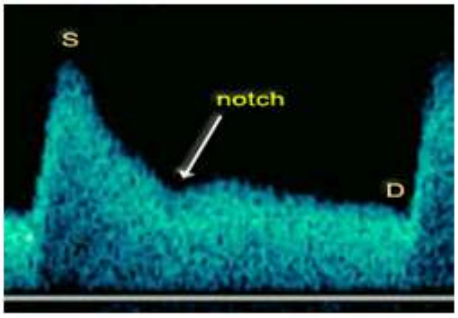
In this study pregnant bidi workers attending antenatal Outpatient department were selected for the study. Non bidi workers were selected as controls. Tobacco chewers and smokers were excluded from study. The study population comprises of 100 women with singleton pregnancies of bidi worker women at 37-38 weeks gestational age and 100 cases of pregnant non bidi workers at 37-38 weeks gestational age. In all pregnancies, gestational age is calculated by LMP and earliest ultrasound in first trimester. Detailed occupational history was taken. It included number of bidies prepared per day, number of hours she is working daily, number of years she is preparing bidies and occupation of her husband. Economical history was taken including her daily wages, weekly income of her husband and from this their monthly income calculated assessing their socioeconomic status. With written consent USG examination including Color Doppler and pulsed Doppler velocimetry (L and T Company) carried out. With uterine artery flow velocity waveforms are sampled from ascending uterine artery in lateral wall of lower quadrant of uterus. A 3 mm pulsed Doppler gate is used for the uterine artery and smallest angle between the Doppler beam and vessel was chosen to obtain maximal flow velocity wave form. In all examination color and pursed Doppler system incorporating a 3-5m Hz trans abdominal convex transducer were used. The high pass filter was set at 50Hz. Resistance Index was calculated as

$$RI = \frac{\text{Peak systolic velocity - End diastolic velocity}}{\text{Peak systolic velocity}}$$

Amniotic fluid index was determined using four quadrant method. The amniotic fluid index (AFI) is calculated by adding the depth in centimetres of the largest vertical pocket in each of four equal uterine quadrants[4]. Umbilical artery Doppler was performed in both study and control group cases to calculate S/D ratio[5].

RESULTS

In present study, 70% of cases were in age group of 21-25 year. This was the age group of maximum fertility followed by 15% in 26-30 year age group. Minimum numbers of subjects were between the age group of >30 yrs (4%).This was the age group of declining fertility. In our study 87% of study group and 78% of control group subjects were illiterate. In both the groups 60% of cases were primigravidae followed by 20% second gravidas, 16% third gravidas and 4% fourth gravid or more. In study (pregnant bidi workers) group 2% of women had uterine artery RI less than 0.60, 35% of women had uterine artery RI between 0.60 to 0.70 and 73% of women had uterine artery RI more than 0.70. In control (pregnant non bidi workers) group 46% of women have uterine artery RI less than 0.60, 50% of women had between 0.60 to 0.70 and 4% of women had uterine artery RI more than 0.70.



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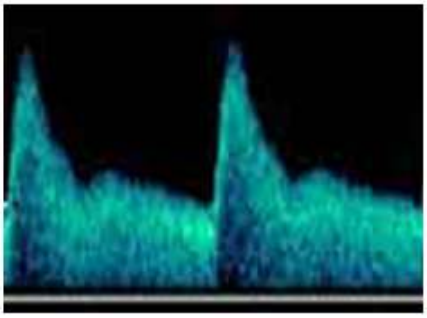

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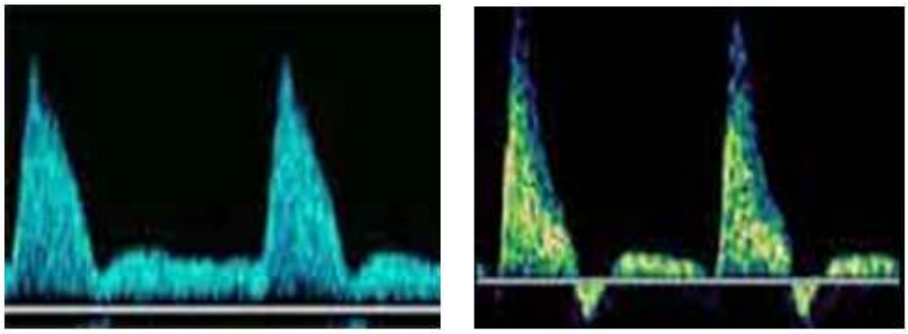

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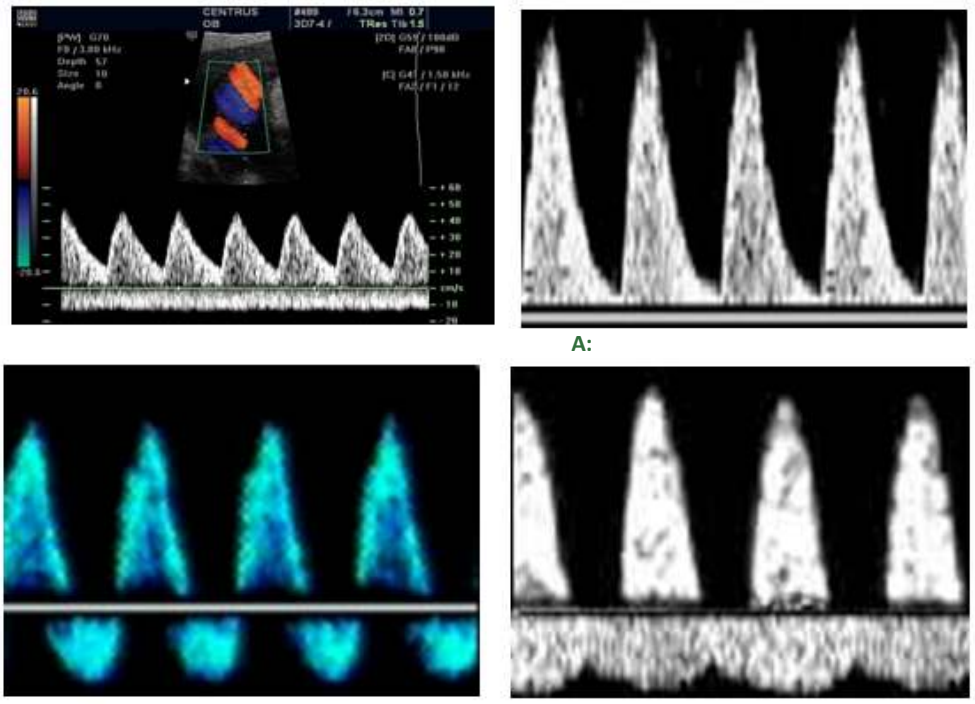
Figure 1: Waveform ofuterine arteryinimpaired placentation **A:** Notch in Early Diastole and Decreased Flow in Late Diastole **B:** Normal Impedance to Flow with Early Diastolic Notching **C:** Increased Impedance to Flow with Early Diastolic **D:** Very High Resistance Flow Notchingwith Reverse Diastolic Flow

Table 1: Comparison of uterine artery RI between study and control group

Uterine artery RI	Study Group No. of cases	Control Group No. of cases
Mean	0.72	0.60
SD	0.05	0.04
95% confidence limit	0.62 - 0.82	0.52 - 0.68

(Z test = 10.61; p< 0.001)

There was significant difference in mean uterine artery resistance index between study and control group. Pregnant bidi workers had significantly higher uterine artery resistance index as compared to pregnant non bidi workers. In study (pregnant bidi workers) group 34% of women had umbilical artery S/D ratio less than 2.00, 58% of women had between 2.00 to 3.00 and 8% of women had umbilical artery S/D ratio more than 3.00.In control (pregnant non bidi workers) group 93% of women had umbilical artery S/D ratio less than 2.00, 7% of women had between 2.00 to 3.00 and none of women (0%) have umbilical artery S/D ratio more than 3.00.



A:

B: C:

Figure 2: Waveform of Umbilical artery in impaired placentation **A:** High Pulsatality Index Diastolic Frequencies **B:** Absence and Reversal of End **C:** High PI, EDV In Umbilical Arteryand Pulsations In Umbilical Vein

Table 2: Comparison of Umbilical artery S/D Ratio between study and control group

Umbilical artery S/D ratio	Study group	Control group
Mean	2.17	1.76
SD	0.50	0.17
95% confidence limit	1.67-2.67	1.59-1.93

Table 3: Correlation between number of bidies prepared per day and degreeofaffection of different paramaters

Number of bidies prepared/day	<501	501-1000	>1000
Uterine artery RI Mean ± SD	0.71 ± 0.37	0.78 ± 0.08	0.88 ± 0.01
Umbilical artery S/D Ratio Mean ± SD	2.11 ± 0.35	2.29 ± 0.55	2.99 ± 0.82
Amniotic fluid index (AFI) Mean ± SD	9.18 ± 1.50	6.46 ± 0.63	3.75 ± 0.95

In study group, pregnant bidi workers rolling >1000 bidies/day had higher values of uterine artery RI than pregnant bidi workers rolling <1000 bidies/day; this difference was statistically significant (p value < 0.001). This means uterine artery RI index goes on increases with increase in number of bidies prepared/day. The pregnant bidi workers rolling >1000 bidies/day had higher values of umbilical artery S/D ratio than pregnant bidi workers rolling <1000 bidies/day; this difference was also statistically significant (p< 0.001). This means umbilical artery S/D ratio goes on increases with increase in number of bidies prepared per day. The pregnant bidi workers rolling >1000 bidies/day had lower values of amniotic fluid index (AFI) than pregnant bidi workers rolling <1000 bidies/day; this difference is statistically significant (p< 0.001). This means amniotic fluid index (AFI) goes on decreases with increase in number of bidies prepared per day.

DISCUSSION

Bidi industry is part and parcel of Solapur. Solapur is known for textile industries and bidi industries and around 65,000 women are employed in these bidi industries. These industries supply raw material like tobacco and tendu leaves to these women. They take them home and put many hours in rolling bidies. While making bidies, tobacco is absorbed through intact skin of hand and inhaled as dust. In India rolling of bidies is common in women. It is as hazardous as smoking during pregnancy. Making 1000 bidies per day during pregnancy has equal reduction in birth weight as that caused by smoking 25 cigarettes per day during pregnancy. Previous three studies have been made in the Solapur to study the obstetric outcome in bidi workers[6]. It is well known that outcome of pregnancy depends upon antenatal care and proved that pregnancy complications are high in unregistered cases. There was no difference in ANC registration status in both the groups. In bidi working pregnant women very few women get proper antenatal care. They came for registration at around 28 to 30 weeks of gestational age. After that they came directly for delivery. Most of our patients were in the age group of 21-25 years. This is the age group of maximum fertility. Fridrick found that preterm deliveries were more commonly seen in low maternal age, low maternal weight and in smokers[7]. WisborgK *et al*[8] found no modification by maternal age of the association between smoking and preterm birth. Simpson[9] found that the babies of smokers are affected independent of age. In smokers increasing maternal age usually means a longer exposure to cigarettes that might interact with direct toxic effects of tobacco smoke. In present study, 60% of cases of both groups were primigravidas and 4% were fourth gravidaeor more. Kleinman and co-workers[10] found a difference between primipara and multipara in terms of effect of smoking. There was no significant difference in literacy in both groups. Because of illiteracy these women were not aware of antenatal care, hygiene, proper diet. They also did not know about hazardous effect of tobacco handling and did not take any preventive measure for the same. Nutritional status is directly proportional to the socioeconomic condition of the family. These women were poorly nourished. They spent many hours in rolling bidies neglecting their nutrition. In normal pregnancies, the flow velocity waveform showed a good diastolic flow and fall in indices as pregnancy progress a low diastolic flow and high indices characterized the pregnancies with abnormal outcomes. There are many parameters to assess the uterine artery flow velocity waveforms such as pulsatility index, resistance index, S/D ratio and diastolic notch. Out of these parameters we have chosen R.I., as it is easy to measure and has better predictive value. The uterine artery had better sensitivity and specificity as compared to the umbilical artery. According to study carried out at Springer New York[11], all of the uterine artery indices were statistically higher in the study group in comparison with the control group both before and after smoking. There was no significant change in the uterine artery waveform indices that could be attributed to the acute effect of smoking in the study group. According to Ates and collegues[12], the nicotine load of a single cigarette may be inadequate to cause a detectable decrease in utero-placental blood flow. According to Albuquerque and collegues[13], in smokers a diastolic notch was more frequently observed in the uterine artery waveform than in controls (p<0.05), suggestive of a greater resistance in the uterine vasculature. In our study, bidi working group 2% of women had uterine artery RI less than 0.60; 35% of women have uterine artery RI between 0.60 to 0.70 and 73% of women have uterine

artery RI more than 0.70.Whereas, in control (non bidi working) group 46% of women have uterine artery RI less than 0.60; 50% of women have uterine artery RI between 0.60 to 0.70 and 4% of women have uterine artery RI more than 0.70.The difference is found to be statistically significant (p< 0.001). Bidi workers had higher uterine artery RI compared to non bidi workers. This means uterine artery RI index increases with number of bidies prepared per day. Umbilical artery Doppler is the most commonly performed Doppler study for assessment of fetal well-being in clinical practice. In normal pregnancy, resistance to blood flow in the uteroplacental unit decreases, as pregnancy advances, resulting in an increase in diastolic flow in umbilical artery Doppler and a gradual fall in the S/D ratio. In placental insufficiency, the resistance to blood flow increases in the placental vessels, which is reflected in the umbilical artery Doppler as increased S/D ratio, RI and PI. The abnormality in umbilical artery Doppler can vary from elevated S/D ratio to absent end diastolic flow to reversed diastolic flow at its worst Doppler velocimetry is useful in assessment of fetal well-being as well as in deciding the intensity and frequency of fetal monitoring. A study was carried out at Springer, New York to study acute effects of maternal smoking on the uterine and umbilical artery blood velocity waveforms and suggest that smoking causes an increase in vascular resistance of the placenta and umbilical cord when used chronically[11]. Ates and collegues found that maternal heart rate significantly increased after smoking. Baseline FHR and FHR variability remained unchanged. There were no significant changes between maximum and minimum flow velocities, pulsatility index (PI), resistance index (RI) and systolic/diastolic flow ratio (S/D) of umbilical and middle cerebral arteries. The nicotine load of a single cigarette may be inadequate to cause a detectable decrease in utero-placental blood flow; however, smoking prior to the FHR recording may alter the FHR reactivity[12]. Albuquerque and collegues found that in the uterine artery there was no significant difference between the systolic/diastolic (S/D) ratio in smoking and non-smoking women; however, in smokers, a diastolic notch was more frequently observed in the uterine artery waveform than in controls (p<0.05), suggestive of a greater resistance in the uterine vasculature. In the umbilical artery, the S/D ratio was significantly greater in smokers than in non-smokers[13]. In our study, bidi working group 34% of women have umbilical artery S/D ratio less than 2.00; 58% of women have umbilical artery S/D ratio between 2.00 to 3.00 and 8% of women have umbilical artery S/D ratio more than 3.00. Whereas, in control (non bidi working) group 93% of women have umbilical artery S/D ratio less than 2.00; 7% of women have umbilical artery S/D ratio between 2.00 to 3.00 and none of women have umbilical artery S/D ratio more than 3.00. In our study bidi working group has their mean S/D ratio 2.17. (95% confidence limit was 1.67-2.67). In non bidi working group has their mean umbilical artery S/D ratio 1.76. (95% confidence limit was 1.59-1.93).In study group bidi workers rolling >1000 bidies per day had higher values of umbilical artery S/D ratio than bidi workers rolling < 501 bidies per day; this difference is statistically significant. (p< 0.001). This means umbilical artery S/D ratio increases with number of bidies prepared per day. In the late second trimester and in the third trimester, amniotic fluid volume is largely contributed by fetal urinary production. The compromised fetus produces less urine and consequently oligohydramnios. Various ultrasound techniques have been evolved for assessing amniotic fluid volume. Phelan *et al*[4] proposed amniotic fluid index (AFI) as a more objective and reproducible method as it estimates the amount of amniotic fluid in four quadrants. The uterus is arbitrarily divided into four quadrants by the umbilicus transversely and linea nigra vertically. The largest vertical pocket, free of fetal parts and loops of cord, in each quadrant is measured. An AFI of 5-18 cm is considered normal. The mechanism is probably uteroplacental insufficiency which explains the genesis of both fetal growth restriction and decreased liquor. Fetal hypoxia causes redistribution of cardiac output in favour of fetal brain diverting the blood supply away from kidneys and lungs. This results in reduced fetal urinary production and decreased lung secretions, which contribute to amniotic fluid volume. The mean amniotic fluid index (AFI) of study group was 8.56 cm (95% confidence limit from 4.66 cm to 12.46 cm) and of control group was 12.19 cm (95% confidence limit from 6.56 cm to 17.81 cm).This means that bidi working group was associated with significantly low amniotic fluid index as compared with non-bidi working group. The amniotic fluid index (AFI) decreases with increase in number of bidies prepared per day. Color Doppler is useful in studying adverse effects of tobacco handling in bidi workers on fetoplacental circulation. There is need to set up antenatal care clinic in bidi industrial areas. Pregnant bidi workers should get dietary allowance and paid leave. Use of gloves and mask during rolling bidies will reduce adverse effects of tobacco handling in pregnant bidi workers. Future studies like doing maternal serum nicotine levels and cord blood nicotine levels will through light on whether the ingredients of tobacco cross placental barrier.

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