ORIGINAL ARTICLE

Maternal Passive Smoking and its Effect on Maternal, Neonatal and Placental Parameters

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Summary

A study was undertaken to 1) determine the effects of tobacco smoke exposure on maternal and neonatal weight and body mass index (BMI) and placental weight, volume and surface area and 2) establish any correlations between the placental surface area, volume and weight with maternal and neonatal body weight and BMI in mothers exposed to cigarette smoke. A total of 154 full-term placentae, 65 from mothers exposed to tobacco smoke and 89 from non-exposed mothers were collected from Kuala Lumpur Maternity Hospital. The placental surface area was determined using a stereological grid, the volume by Scherle's method and the weight by using an electronic weighing machine. In general there were no differences in maternal, placental and neonatal parameters between the exposed and non-exposed groups. However, there were significant correlations between placental weight with maternal weight and maternal BMI in both exposed ($r = 0.315$; $p = 0.013$) and ($r = 0.265$; $p = 0.038$), and non-exposed ($r = 0.224$; $p = 0.035$) and ($r = 0.241$; $p = 0.023$) mothers. It was also found that the maternal weight on admission correlated significantly with placental weight in both Malay ($r = 0.405$; $p = 0.020$) and Indian ($r = 0.553$; $p = 0.050$) passive smokers. Correcting the placental parameters for the maternal weight had no effect on the results.

Key Words: Passive smoking, Placenta, Placental coefficient, Maternal weight, Neonatal weight

Introduction

The World Health Organization has defined passively inhaled smoke as the smoke that individuals breathe when they are located in the same airspace as smokers[1]. Tobacco smoke contains over 4000 chemicals including carbon monoxide, nicotine, tar, ammonia, arsenic, cyanide and lead. A study has shown that these toxins are found in higher concentration in those exposed to tobacco smoke (passive smokers) than those in the main stream smoke (active smokers)[2]. The adverse effects of cigarette smoke including morphological and functional alterations on pregnancy are well documented[3,4].

Passive smoking has also been found to be an independent risk factor for low birth weight, spontaneous abortion, perinatal and cot death[5,6]. Researchers have shown that there are significant relationships between exposure to tobacco smoke and maternal factors such as body weight, height,

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haematological indices and neonatal factors such as birth weight and gestational age[4,7]. However, to the best of our knowledge, there are no local publications on the relationship between placental surface area, volume and weight of passive smoking mothers with maternal and neonatal body weight and body mass index (BMI).

In view of this, the present study was undertaken to determine:

1. the effects of exposure to tobacco smoke on maternal and neonatal weight and body mass index (BMI) and placental weight, volume and surface area.
2. any correlation between placental surface area, volume and weight with maternal and neonatal body weight and body mass index (BMI) in mothers exposed to cigarette smoke.

Materials and Methods

Population and sample

One hundred and fifty four samples of freshly delivered placentae from full term pregnancies, were randomly collected from Kuala Lumpur Maternity Hospital (26,000 deliveries per annum). Sixty-five (Malay -33, Chinese - 18, Indian - 14) were from passive smokers and 89 (Malay - 31, Chinese - 35, India - 23) were from controls. In this study, all the passive smoking mothers were exposed to between 5 – 14 cigarettes per day.

Only mothers exposed to tobacco smoke in the house or office (assessed via questionnaire) were considered for the study. Normal mothers were defined, as those who have not been exposed to tobacco smoke in the house or office. Both the exposed and non-exposed mothers should not have had any history of illness such as diabetes mellitus, hypertension, anaemia and without complications before and after labour. All patients had spontaneous vaginal deliveries with full term live-born infants with no detectable congenital malformations at birth. Placentae from mothers who underwent Caesarean section or any assisted delivery such as ventouse or forceps were excluded. Maternal and neonatal data such as mother's body weight on admission, height, gestational age, parity, diseases, birth weight and length of the newborn were obtained from the hospital and antenatal records.

Measurement of placental parameters

In the study, the placental surface area was estimated by placing a grid (30 x 30cm marked in 1cm increments) on the cotyledons. The surface area in contact with the grid was estimated as the apparent placental surface area (including the intercotyledonary surface area).

The umbilical cord was clamped at the placental insertion immediately after delivery and cord cut approximately 5 mm from the insertion point before the membranes were trimmed away and blood clots removed[8]. The surface area and volume of placenta were estimated by using a grid[9] and Scherle's method [10] respectively. The weight was determined by using an electronic weighing machine.

Data analysis

The placental and neonatal datasets were corrected for maternal weight on admission (e.g. placental weight ÷ maternal weight on admission) and then were normalized by arcsine transformation {$\sin^{-1}\sqrt{}$ (corrected placental weight ÷ 100)}, referred to as specific values. The correction is necessary to rule out any effect of maternal weight on placental parameters. The placental weight was divided with neonatal weight and this was known as the placental coefficient.

The maternal, placental and neonatal datasets were analysed using analysis of variance (ANOVA) to determine the effects of exposure to tobacco smoke. These datasets also were analysed with Pearson's correlation to compare the association between different variables by ethnicity and exposure to tobacco smoke. Data were analyzed using SPSS for Windows (Version 9.0, SPSS Inc. Chicago, Illinois, USA).

Questionnaires and consent

A questionnaire was given to the mothers before labour. Questions included basic information such as smoking habits of mother and other household or office members, occupation and medication. Written consent was obtained from each eligible pregnant woman who was willing to allow her placenta for research purposes. An approval from the Faculty Ethical Committee was obtained before the study was conducted.

Results

Effect of exposure to tobacco smoke

Table I shows the mean value (95% confidence interval) of the placental, maternal and neonatal parameters of passive smoking and normal mothers. There were no significant effects ($p>0.05$) of exposure

to tobacco smoke on placental surface area, volume and weight. Similar results were also seen in the maternal and neonatal parameters, where there were no significant differences ($p>0.05$) between those exposed to tobacco smoke and those who were not exposed.

Placental parameters versus maternal parameters

No significant correlations ($p>0.05$) were observed between the placental volume with maternal weight and maternal BMI of the passive smoking mothers. However, there were significant correlations ($p<0.05$) between the placental volume with maternal weight ($r = 0.215$; $p = 0.043$) and maternal BMI ($r = 0.239$; $p = 0.024$) in normal mothers. Placental weights were found to be significantly correlated with maternal weight and BMI in both the exposed ($r = 0.315$; $p = 0.013$) and ($r = 0.265$; $p = 0.038$), and non-exposed ($r = 0.224$; $p = 0.035$) and ($r = 0.241$; $p = 0.023$) mothers, respectively. No significant association ($p>0.05$) between the placental surface area and maternal weight and BMI in both exposed and non-exposed were observed.

Placental parameters versus neonatal parameters

Table II shows correlation coefficients, r, (significant value, p) between placental weight, volume and surface area with neonatal birth weight and neonatal BMI in passive smoking and normal mothers. Placental weight, volume and surface area were significantly correlated ($p<0.05$) with neonatal birth weight and BMI in both the exposed and non-exposed groups.

Effect of the ethnicity

When ethnicity was taken into consideration, maternal weight on admission was significantly correlated with placental weight in both Malay ($r = 0.405$; $p = 0.020$) and Indian ($r = 0.553$; $p = 0.050$) passive smokers. No significant correlations ($p>0.05$) were observed between placenta, maternal and neonatal parameters in the Chinese ethnic group.

Specific placental parameters versus neonatal parameters

Neonatal birth weight and BMI were significantly correlated ($p<0.05$) with specific placental surface area ($r = 0.287$; $p = 0.021$) and ($r = 0.228$; $p = 0.070$), placental volume ($r = 0.424$; $p = 0.001$) and ($r = 0.398$; $p = 0.001$) and placental weight ($r = 0.449$; $p = 0.001$) and ($r = 0.414$; $p = 0.001$), respectively, in passive smoking mothers. Similar findings were also observed in the normal mothers, where the neonatal birth weight and BMI were significantly correlated with specific placental surface area ($r = 0.285$; $p = 0.007$) and ($r = 0.274$; $p = 0.009$), placental volume ($r = 0.332$; $p = 0.01$) and ($r = 0.291$; $p = 0.006$) and placental weight ($r = 0.344$; $p = 0.001$) and ($r = 0.287$; $p = 0.006$) respectively.

Placental coefficient:

The placental coefficient showed negative correlation with both the maternal weight ($r = 0.038$; $p = 0.767$) and BMI ($r = 0.048$; $p = 0.713$) in passive smoking mothers. Meanwhile a positive association was established between placental coefficient with maternal weight ($r = 0.047$; $p = 0.660$) and maternal BMI ($r = 0.050$; $p = 0.642$) in the normal mothers.

Table I: Mean (95% confidence interval) of the placental, maternal and neonatal parameters in passive smoking and normal mothers

Parameter	Passive smoker (n = 65)	Normal (n = 89)	P
Placental surface area (cm^2)	287.58 (272.03-303.14)	294.87 (281.68-308.06)	ns
Placental volume (cm^3)	500.04 (476.05-524.04)	503.67 (483.33-524.02)	ns
Placental weight (gm)	528.80 (503.70-553.90)	531.87 (510.59-553.16)	ns
Specific placental surface area (cm^2/kg) †	12.26 (11.87-12.65)	12.46 (12.13-12.79)	ns
Specific placental volume (cm^3/kg) †	16.31 (15.85-16.77)	16.39 (16.00-16.77)	ns
Specific placental weight †	16.79 (16.33-17.25)	16.85 (16.46-17.24)	ns

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Parameter	Passive smoker (n = 65)	Normal (n = 89)	P
Placental coefficient #	0.171 (0.165-0.176)	0.168 (0.163-0.172)	ns
Maternal weight (kg)	63.61 (61.19-66.02)	63.76 (61.71-65.81)	ns
Maternal BMI (kg/m^2)	26.41 (25.60-27.53)	26.72 (25.69-27.33)	ns
Neonatal birth weight (kg)	3.08 (2.98-3.19)	3.16 (3.07-3.25)	ns
Neonatal BMI (kg/m^2)	12.94 (12.63-13.24)	13.09 (12.82-13.34)	ns

BMI = Body Mass Index
ns = not significant
† The placental datasets were corrected for maternal weight and then were normalized by arcsine transformation, referred as specific value.
# The placental weight was divided with neonatal weight, referred as placental coefficient.

Table II: Correlation coefficient, r, (significant value, p) between placental weight, volume and surface area with neonatal birth weight and neonatal body mass index (BMI) in passive smoking and normal mothers

Placental parameter	Passive smoker (n = 65)		Normal (n = 89)	
	Neonatal birth weight	Neonatal BMI	Neonatal birth weight	Neonatal BMI
Placental weight	r = 0.750 (p = 0.001)	r = 0.657 (p = 0.001)	r = 0.633 (p = 0.001)	r = 0.533 (p = 0.001)
Placental volume	r = 0.708 (p = 0.001)	r = 0.614 (p = 0.001)	r = 0.626 (p = 0.001)	r = 0.545 (p = 0.001)
Placental surface area	r = 0.547 (p = 0.001)	r = 0.442 (p = 0.001)	r = 0.552 (p = 0.001)	r = 0.511 (p = 0.001)

$p < 0.05$ indicates a statistically significant difference

Discussion

Effect of exposure to tobacco smoke
Although some authors have found significant alterations of surface area, volume and weight in the placenta of the mothers exposed to cigarette smoke [5,11,12], in the present study, no significant differences were demonstrated between exposed and non-exposed groups to tobacco smoke. This is true for both the corrected and uncorrected maternal weight parameters, suggesting that maternal weight may not have a significant effect on placental weight, volume and surface area.

Other studies have demonstrated that the volume of the placenta is significantly lowered by nicotine infusion, which is a very potent vasoconstrictor and has been shown to concentrate in the placental tissues [13, 14]. The present study has found that although the placental volume of the passive smoking mothers was slightly lower than the normal mothers, it was not significant.

Effect of ethnicity
Although the placental weight was significantly correlated with maternal weight and BMI in the overall passive smoking group, there were no significant correlations observed in the Chinese mothers. This may due to the socio-economic factors as being reported by Sivarao et al, 2002 [8].

Placental coefficient:
The ratio between placental weight and newborn weight (placental coefficient) was higher in the passive smoking group. Similar observation was reported by Rocha et al, 1998 [4] and Van der Salm et al, 1994 [15] although this was observed in active smoking women. They thought that this might be due to the adaptation of the placenta in order to increase the oxygen supply to the foetus.

Neonatal birth weight and BMI:
The present study did not find significant differences in birth weight and BMI between exposed and non-exposed mothers. However, neonates of the exposed group are at risk of having lower birth weight and BMI [16, 17] as a result of foetal oxygen deprivation.

Limitation of the study:
This study has limitations in investigating the relationship between the maternal, placental and neonatal parameters since the gestational age was estimated by menstrual dates (last menstrual period). Other researchers have used both the menstrual dates and ultrasound which could estimate the gestational age accurately [18, 19].

Future studies should utilise urine cotinine estimation which is more accurate indicator of the exposure to tobacco smoke need to be undertaken.

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