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Weight gain during pregnancy and placenta morphology: a prospective cohort study

L.-J. WANG[1], D.-Z. FAN[1,2], H.-X. GUO[1], B.-S. CHEN[1], Z.-P. LIU[1,2]

[1]Department of Obstetrics, Affiliated Foshan Women and Children Hospital, Southern Medical University, Foshan, Guangdong, China
[2]Foshan Fetal Medicine Research Institute, Affiliated Foshan Women and Children Hospital, Southern Medical University, Foshan, Guangdong, China

Abstract. – OBJECTIVE: The aim of this study was to assess the association between maternal weight gain and placenta morphology in the complete placenta previa pregnancies.

PATIENTS AND METHODS: This was a prospective clinical cohort study. Pregnancy weight gain was defined as the difference between delivery and at first trimester. Morphological parameters, including placenta length, breadth, thickness, length-breadth, surface area, weight, and fetoplacental weight ratio, were direct measured delivery.

RESULTS: Eighty-five women were included in this study. Maternal weight gain was 11.12 ± 3.95 kg. Placenta length, breadth, thickness, length-breadth, surface area, weight and fetoplacental weight ratio were 19.42 ± 1.97 cm, 18.29 ± 1.80 cm, 2.18 ± 0.38 cm, 1.13 ± 0.80 cm, 281.60 ± 57.23 cm^2, 569.05 ± 118.77 g, and 4.88 ± 0.88, respectively. Correlation analysis showed that there was a positive correlation between maternal weight gain and placenta length (r = 0.261, *p* = 0.016), placenta breadth (r = 0.239, *p* = 0.028), and placenta surface area (r = 0.254, *p* = 0.019). In the linear regression model, maternal weight gain was significantly associated with placenta length [β (95% CI): 0.130 (0.025-0.236)], breadth [β (95% CI): 0.109 (0.012-0.205)], and surface area [β (95%CI): 3.677 (0.615-6.739)]. The results were still stable after adjusting for pre-pregnancy weight.

CONCLUSIONS: Maternal weight gain in pregnancy was associated with placental length, placental breadth, and placental surface area in a complete placenta previa pregnancies. Considering the single center data, further studies are needed to recognize the significance of the association analyzed in our study.

Key Words:
Maternal weight gain, Placenta morphology, Complete placenta previa, Pregnancy.

Introduction

Some clinical studies showed that placenta morphology, such as size, shape, and weight, could affect maternal and neonatal outcomes, including fetal growth rate, postnatal bone size and density, cardiovascular risk, and autism spectrum disorder[1-5]. Meanwhile, environmental factors and maternal conditions, such as prenatal phthalate exposure[6], gestational diabetes mellitus[7], gestational hypertension[8], and psychosocial stress[9], are also confirmed to be associated with placenta morphology. However, there are still some modifiable lifestyle risk factors, like maternal weight gain, which are not fully understood.

In this prospective cohort study, we are trying to explore the association between maternal weight gain during pregnancy and placenta morphology, including placenta length, breadth, thickness, length-breadth, surface area, weight, and fetoplacental weight ratio in complete placenta previa pregnancies.

Patients and Methods

This study is a continuation of previous cohort research[10]. All participants and their direct relatives (husband or parents) signed informed consent before enrollment. The study strictly adhered to the Helsinki Declaration and was approved by the Hospital Ethical Committee (20160101). Demographic and clinical variables were collected from both maternal and infant charts. The procedures have been previously described[11]. Maternal weight gain during pregnancy was defined as the difference between at delivery

Corresponding Authors: Zhengping Liu, MD; e-mail: liuzphlk81@outlook.com
Dazhi Fan, MD; e-mail: fandazhigw@163.com

and at the first trimester. Inclusion criteria included: (1) the data of maternal weight were all provided at delivery and at the first trimester; and (2) pregnant women were diagnosed as complete placenta previa after delivery.

Morphological parameters, such as placenta length, breadth, thickness, length-breadth, surface area, weight, and fetoplacental weight ratio, were direct measured at delivery, respectively. Referred to previous studies[2,6], the shape of placenta is regarded as elliptical. The maximum diameter of the elliptical is thought to be the length. The breadth of the placenta is perpendicular to the midpoint of length. A calibration needle is used to measure the maximum thickness. And the placenta length times breadth, multiplied by $\pi/4$ as the placenta area.

Statistical Analysis

Data were described using the mean ± standard deviation (SD) and number (frequency). The relationship between pregnancy weight gain and placental morphology was investigated using correlation analysis and linear regression analysis. In addition, the analyses were also adjusted for pre-pregnancy weight. SPSS software (version 13.0; SPSS Inc., Chicago, IL, USA) was used to analysis. The p-value ≤ 0.05 was considered significant.

Results

Eighty-five women were included in this study. The gestational age and maternal age were 36.19 ± 1.74 weeks and 33.79 ± 5.14 years. On average, the maternal height was 158.97 ± 4.71 cm. The baseline characteristics were displayed in Table I. Data of pre-pregnancy weight, pre-delivery weight, and pregnancy weight gain were 54.52 ± 8.40 kg, 65.63 ± 8.92 kg, and 11.12 ± 3.95 kg, respectively. Thirty-six (42.4%) women were nullipara. The infant weight was 2722.06 ± 474.43 g. Placenta morphology's data, such as placenta length, breadth, thickness, length-breadth, surface area, weight and fetoplacental weight ratio was 19.42 ± 1.97 cm, 18.29 ± 1.80 cm, 2.18 ± 0.38 cm, 1.13 ± 0.80 cm, 281.60 ± 57.23 cm^2, 569.05 ± 118.77 g, and 4.88 ± 0.88, respectively.

Correlation analysis showed that there was a positive correlation between pregnancy weight gain and placenta length (r = 0.261, p = 0.016), placenta breadth (r = 0.239, p = 0.028), and placenta surface area (r = 0.254, p = 0.019). After adjusting for pre-pregnancy weight, the results were also found for placenta length (r = 0.276, p = 0.011), placenta breadth (r = 0.251, p = 0.021), and placenta surface area (r = 0.267, p = 0.014). However, other parameters of placenta, such as placenta thickness, length-breadth, weight, and fetoplacental weight ratio were not significant for pregnancy weight gain (Table II, Figure 1).

Table I. Descriptive statistics for demographics and placenta [mean ± SD (range) or n (%)].

Characteristics	Mean ± SD/n	Range/%
Maternal age (years)	33.79 ± 5.14	23.97-44.30
Gestational age (weeks)	36.19 ± 1.74	31.00-38.71
Height (cm)	158.97 ± 4.71	146.00-170.00
Pre-pregnancy weight (kg)	54.52 ± 8.40	41.00-81.00
Pre-delivery weight (kg)	65.63 ± 8.92	52.00-99.70
Pregnancy weight gain (kg)	11.12 ± 3.95	2.00-24.00
Parity		
0	36	42.4
≥ 1	49	57.6
Infant weight (g)	2722.06 ± 474.43	1500.00-4160.00
Placental indicator		
Length (cm)	19.42 ± 1.97	15.00-26.00
Breadth (cm)	18.29 ± 1.80	15.00-25.00
Thickness (cm)	2.18 ± 0.38	1.50-3.00
Length-breadth (cm)	1.13 ± 0.80	0.00-3.00
Surface area(cm^2)	281.60 ± 57.23	176.71-490.87
*Weight (g)	569.05 ± 118.77	300.00-999.00
*Fetoplacental weight ratio	4.88 ± 0.88	3.19-7.83

SD, standard deviation; *Data were missing for six women.

Table II. Correlation analyses of pregnancy weight gain and placenta morphology.

	Length	Breadth	Thickness	Length-breadth	Surface area	Weight	Fetoplacental weight ratio
Pregnancy weight gain	r: 0.261; *p*: 0.016	r: 0.239; *p*: 0.028	r: 0.164; *p*: 0.133	r: 0.106; *p*: 0.333	r: 0.254; *p*: 0.019	r: 0.078; *p*: 0.493	r: 0.133; *p*: 0.243
Pregnancy weight gain*	r: 0.276; *p*: 0.011	r: 0.251; *p*: 0.021	r: 0.149; *p*: 0.176	r: 0.115; *p*: 0.298	r: 0.267; *p*: 0.014	r: 0.079; *p*: 0.492	r: 0.139; *p*: 0.226

SD, standard deviation; *Data were missing for six women.

In the linear regression model, pregnancy weight gain was significantly associated with placenta length [β (95% CI): 0.130 (0.025 - 0.236)], breadth [β (95% CI): 0.109 (0.012 - 0.205)], and surface area [β (95% CI): 3.677 (0.615 - 6.739)]. After adjusting for pre-pregnancy weight, the above three parameters of placenta were still associated with pregnancy weight gain. However,

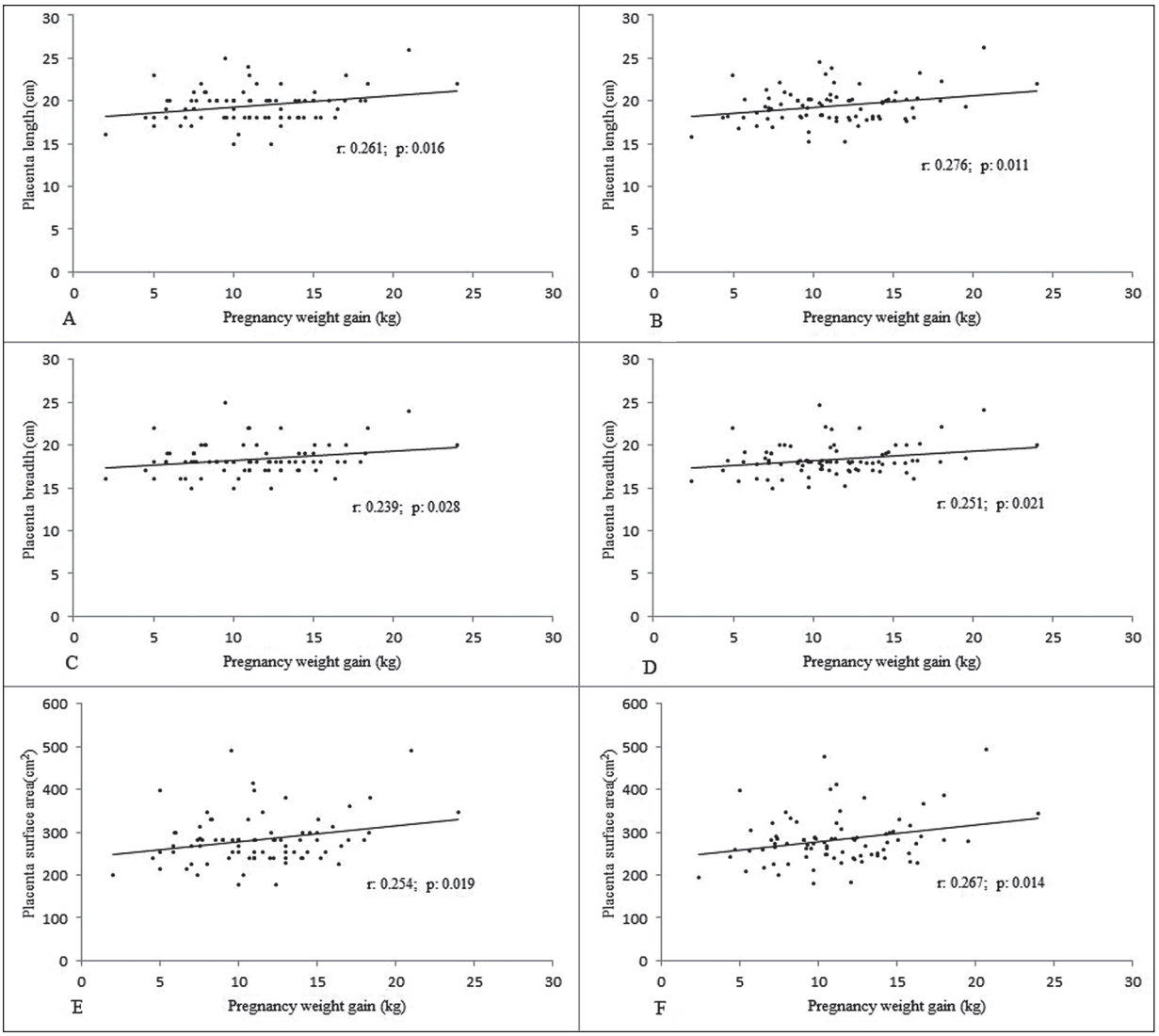

Figure 1. Correlation between pregnancy weight gain and placenta morphology. **A**, Pregnancy weight gain and placenta length; **B**, pregnancy weight gain and placenta length after adjusting for pre-pregnancy weight; **C**, pregnancy weight gain and placenta breadth; **D**, pregnancy weight gain and placenta breadth after adjusting for pre-pregnancy weight; **E**, pregnancy weight gain and placenta surface area; **F**, pregnancy weight gain and placenta surface area after adjusting for pre-pregnancy weight.

other parameters were not related to pregnancy weight gain in unadjusted or adjusted regression analyses (Table III).

Discussion

In this prospective cohort study, we have identified that maternal weight gain was significantly associated with placenta morphology, including placenta length, breadth, and surface area in pregnant women with complete placenta previa. However, other parameters, such as placenta thickness, length-breadth, weight, and fetoplacental weight ratio, were not found significant with maternal weight gain.

Placenta previa is defined as the placenta overlying the endocervical os. It is characterized as complete placenta previa when the placenta covers the internal cervical os completely[12]. It is associated with lots of adverse maternal and fetal-neonatal complications, such as perinatal hemorrhage, maternal anemia, preterm birth, and low birth weight[13-15]. The incidence of placenta previa is about 0.52% around the world[16]. Our previous systematic review reported that it reached to 1.24% among Chinese deliveries[17].

Placenta is vital to maintain the homeostasis of the intrauterine environment. It plays an important role in fetal growth and development. It has been reported that sex of the infant, parity, maternal age, and racial difference could influence placenta morphology[18,19]. From a Japanese term vaginally delivered singleton population, Matsuda et al[18] emphasized that female baby and nulliparity should be taken into account in evaluating placental weight. Similarly, de Jongh et al[19] found Black/Non-Hispanic advanced maternal age was associated with a decrease in placental weight and placental weight/birth weight ratio in very low birth weight infants.

For a modifiable lifestyle factor, maternal weight gain has always been a hot topic in perinatal complications for researchers. It has been demonstrated that inappropriate maternal weight gain is an independent risk factor for adverse maternal and infant outcomes[20,21]. However, few studies have explored the relationship between maternal weight gain and placenta morphology. To our knowledge, this study, involving multiple placental morphological parameters, is the first to explore their relationship.

Many animal studies and human epidemiological findings have shown that placental surface area could impact its function via affecting the capacity for nutrient transfer[22]. Abnormal placenta surface area could bring various adverse complications for maternal and fetal infant. It included not only perinatal period effects[13,14,23], such as small fetuses, ante- and post-partum hemorrhage, placenta previa, but also long-term effects, like, the physical and mental health of the mother and infant[1,24]. As one of the most serious perinatal complications, complete placenta previa could be thought of placental overgrowth and completely covers the endocervical os[12]. If a pregnant woman with complete placenta previa, cesarean delivery is the best delivery mode. Furthermore, severe intraoperatively hemorrhage, even hysterectomy, is difficult to avoid when the placenta with a full anterior.

In terms of public health, we identified a positive association between maternal weight gain and placental length, breadth, and surface area, regardless of mother's pre-pregnancy weight. In other words, the more maternal weight gain, the more likely it is that a pregnant woman will give birth to a large surface area placenta. It is suspected that maternal weight gain affects the mother and infant outcomes, probably by affecting the placenta size. However, further studies are required to determine causality. This

Table III. Linear regression between pregnancy weight gain and placental morphology.

Variables	β (95% CI)	**β (95% CI)
Length (cm)	0.130 (0.025-0.236)	0.138 (0.032-0.243)
Breadth (cm)	0.109 (0.012-0.205)	0.114 (0.017-0.211)
Thickness (cm)	0.016 (-0.005-2.244)	0.014 (-0.006-0.034)
Length-breadth (cm)	0.021 (-0.022-0.065)	0.023 (-0.021-0.068)
Surface area (cm^2)	3.677 (0.615-6.739)	3.868 (0.801-6.935)
Weight (g)*	2.432 (-4.604-9.469)	2.453 (-4.627-9.533)
Fetoplacental weight ratio*	0.031 (-0.021-0.082)	0.031 (-0.020-0.082)

*Data were missing for six women. **Adjusted for the pre-pregnancy weight (kg).

discovery will provide a new idea for prevention and reducing the incidence of the complete placenta previa.

Several limitations should be pointed on this study. Firstly, the cesarean section procedure often resulted in a partially uncompleted placenta removal, especially in placenta increta or placenta percreta, making the measurements of placental parameters difficult and inaccurate. Secondly, besides maternal weight gain, there are many other factors that might contribute to the condition of complete placenta previa, such as history of miscarriage, implantation site, uterine abnormality, threatened abortion. These factors could affect the results. Lastly, the number of subjects involved in this work was not large[25,26]. Our data suggest that not only larger complete placenta previa, but also expand to placenta previa pregnant women are needed to further explore this association.

Conclusions

Maternal weight gain in pregnancy was associated with estimated with placenta morphology in complete placenta previa pregnant women. This finding should help to direct other intervention studies to determine whether modification of a woman's weight gain trajectory could enhance pregnancy outcomes in women with complete placenta previa. Considering the single center data, further studies are needed to recognize the significance of the association analyzed in our study.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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