

# Clinical features of velamentous umbilical cord insertion and vasa previa

## A retrospective analysis based on 501 cases

Mo Yang, PhD<sup>a</sup>, Yanqiu Zheng, PhD<sup>b</sup>, Mingjing Li, PhD<sup>b</sup>, Wei Li, PhD<sup>b</sup>, Xu Li, PhD<sup>b</sup>, Xinhua Zhang, PhD<sup>b</sup>, Ruihua Wang, PhD<sup>a</sup>, Jing Zhang, PhD<sup>a</sup>, Fuqing Zhou, PhD<sup>a</sup>, Qing Yang, PhD<sup>a,\*</sup>, Gang Li, PhD<sup>c,\*</sup>

### Abstract

To identify the risk factors associated with velamentous cord insertion (VCI) and investigate the association between adverse pregnancy outcomes and VCI in singleton pregnancies and those with vasa previa.

A total of 59,976 single cases admitted from Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital from January 2004 to January 2014 were included in this study. We retrospectively analyzed the perinatal complications, neonatal complications, and the clinical features, as well as the Color Doppler ultrasonography findings of the velamentous placenta and placenta previa.

We reviewed the clinical data of 59,976 women with singleton pregnancies delivered in Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital from January 2004 to January 2014. Risk factors and the risks of adverse pregnancy outcomes including admission to a neonatal unit, fetal death, preterm delivery, low birth weight of <2500 g, the infant being small for its gestation age, low Apgar scores (<7) at 1 and 5 minute were evaluated separately among women with and without VCI by means of logistic regression analyses.

The prevalence of velamentous umbilical cord insertion was 0.84%, and the prevalence of vasa previa was 0.0017%. The independent risk factors for VCI were nulliparity, obesity, fertility problems, placenta previa, and maternal smoking. VCI was associated with a 1.83-, 2.58-, 3.62-, and 1.41-fold increase in the risk of retention in the neonatal unit, preterm delivery (<37 gestation weeks), low birth weight, and small-for-gestational age, compared to pregnancies involving normal cord insertion. Of the women with VCI, 16.1% underwent emergency cesarean section compared to 8.9% ( $P < .001$ ) of women without VCI.

The prevalence of VCI was 0.84% in singletons. The results suggest that VCI is a moderate risk condition resulted in increased risks of prematurity and impairment of fetal growth.

**Abbreviations:** ART = assisted reproductive technology, LBW = low birth weight, SGA = small-for-gestational age, VCI = velamentous cord insertion.

**Keywords:** umbilical cord insertion, vasa previa, velamentous umbilical cord insertion

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MY and YZ contributed equally to this work.

The authors have no conflicts of interest to disclose.

**Synopsis:** Pregnant women with velamentous umbilical cord insertion usually showed poor prognosis. Ultrasonography contributes to the screening of velamentous umbilical cord insertion.

The study protocols were approved by the Ethical Committee of Beijing Gynecology and Obstetrics Hospital.

Each patient signed the informed consent.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

<sup>a</sup> Department of Gynecology and obstetrics, Qinhuangdao Maternal and Child Health Hospital, <sup>b</sup> Department of Gynecology and obstetrics, Qinhuangdao Beidaihe Hospital, <sup>c</sup> Department of Anesthesiology, Qinhuangdao Maternal and Child Health Hospital, Qinhuangdao, China.

\* Correspondence: Gang Li, Department of Anesthesiology, Qinhuangdao Maternal and Child Health Hospital, Qinhuangdao 066000, China (e-mail: 13184725286@163.com).

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### 1. Introduction

Velamentous cord insertion (VCI) refers to a condition in which the umbilical cord inserts into the chorioamniotic membranes rather than the placental mass. The prevalence of VCI is reported to be in a range of 0.1% to 1.8% among all pregnancies, with a risk of up to 10-fold higher in multiple pregnancies.<sup>[1,2]</sup> Compared to the normal cord insertion, the risk of VCI increased in cases with cord insertion low in the uterus.<sup>[2–4]</sup> Women with VCI usually present higher risks of placenta previa,<sup>[5]</sup> placental abruption,<sup>[6–8]</sup> and adverse pregnancy outcomes in singleton pregnancies compared to those without VCI.<sup>[6]</sup> In addition, VCI is associated with increased risks of preterm delivery, low birth weight (LBW), small for the gestation age (SGA), as well as low Apgar scores of 1 and 5 minutes.<sup>[6,9]</sup> Overall, VCI could affect the fetal well-being substantially, and require an emergency cesarean section compared to cases for births with normal cord insertion.<sup>[6]</sup> To date, only a few studies have focused on the risk factors and outcomes of VCI. In this study, we aimed to identify the risk factors for VCI and evaluate the association between adverse pregnancy outcomes and VCI in women with singleton pregnancies. In addition, we aimed to evaluate whether the prevalence and risks associated with the pathogenesis VCI would alternate in a time-dependent manner.

### 2. Materials and methods

In this observational retrospective hospital-based study, we analyzed the data collected from Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital from Jan. 2004 to Jan. 2014. The data included information on maternal and neonatal birth characteristics and fetal death such as live-born and stillborn infants delivered after the 22nd week of pregnancy or with a weight of  $\geq 500$ g. Furthermore, information on background, previous operations, illnesses, obstetric history, smoking, and alcohol consumption were collected from self-administered paper-based questionnaires until 2014 via the internet. Information was complemented by midwife interviews during visits or at the time of delivery in Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital.

The study population included 59,976 women with singleton pregnancies who gave birth to babies in Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital. Those with multiple pregnancies were excluded from the study. Malformations were unspecified and only major defects were included. The weight, length, and insertion of the umbilical cord were examined routinely by midwives after every delivery via vaginal or cesarean means. Placental abruption and placenta previa were diagnosed by clinical examination or on ultrasonography, as previously described.<sup>[7,10]</sup> Estimation of gestational age was based on the date of the last menstrual period, unless a discrepancy of more than 3 days based on the first ultrasound measurements or 7 days based on the second trimester measurements.

The category “unmarried” was defined as any status other than married: cohabiting, single, widowed, or divorced. The infant’s weight was considered SGA in the presence of sex and gestational age-adjusted birth weight of below the normal tenth percentile.<sup>[5]</sup> LBW was defined as infants weighing of  $< 2500$ g. A low Apgar score was defined as a range of 0 to 6. Assisted reproductive technology (ART) involved IVF, ICSI, frozen embryo replacement, and egg donation, however, the rationale for the selection

of the ART method was not available in our obstetric database. Body mass index (BMI) was calculated by dividing body weight in kilograms by squared height in meters ( $\text{kg}/\text{m}^2$ ). Smoking and alcohol consumption during pregnancy and infertility problems were self-reported by the pregnant women. Admission to a neonatal unit was defined as infants requiring more than 24 hours of surveillance.

Differences between the study group and the reference population were assessed by Chi-square and Mann–Whitney *U* tests as appropriate.  $P < .05$  was considered to be statistically significant. Reproductive risk factors of VCI and the risk of adverse infant outcomes were assessed by means of logistic regression modeling including admission to a neonatal unit, fetal death, preterm delivery, LBW, SGA, low Apgar scores at 1 and 5 minutes. Each outcome was analyzed separately. Possible significant, nearly significant ( $P < .1$ ) and clinically important confounding factors were identified from background information, delivery characteristics, and intervention data. For the women with at least 1 abnormality (eg, LBW and preterm delivery), each was considered an independent outcome and was included in both tallies. The data were analyzed using SPSS for Windows 19.0 Software.

The study was approved by the Ethics Committee of Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital. Only anonymized data were used and consequently, the informed consent of the individuals on the register was not needed.

### 3. Results

The prevalence of VCI among women with singleton pregnancies delivered in Kuopio University Hospital was 0.84%. Reproductive risk factors were similar for the women with and without VCI, with the exceptions of history of terminations and pregravid BMI (Table 1). Furthermore, the prevalence of placenta previa was significantly higher among women with VCI compared to the reference population. However, multivariate analysis revealed

**Table 1**  
Reproductive risk factors for VCI among women with singleton pregnancies.

Risk factors	Women with VCI (n=501)	Women with normal cord insertion (n=59475)	P value
Maternal age	31.73 $\pm$ 3.85	31.82 $\pm$ 4.56	.660
Pregravid BMI			
$\leq 24.9$	63.5	66.2	.008
25.0–29.9	20.3	20.8	
30.3–34.9	11.4	9.4	
$\geq 35.0$	4.8	3.6	
Nulliparous	47.6	40.3	.001
Multiparous	53.2	59.2	.001
Prior cesarean section	7.2	8.1	.455
Prior termination	8.2	11.9	.010
Infertility	7.4	3.2	$< .001$
Smoking during pregnancy (>5 cigarettes/d)	6.2	4.2	.027
Alcohol consumption during pregnancy	1.4	1.0	.375
Unmarried	48.5	46.9	.474
ART	3.8	2.7	.134
Placenta Previa	1.6	0.6	.004

ART = assisted reproductive technology, BMI = body mass index ( $\text{kg}/\text{m}^2$ ).

**Table 2**  
**Adjusted OR of VCI among women with singleton pregnancies.**

Characteristics	OR (95% CI)	P value
Nulliparous	1.35 (1.12–1.61)	.003
Multiparous	0.75 (0.67–0.94)	.030
Pregravid BMI	47.6	.001
≤24.9	1	
25.0–29.9	1.13 (0.92–1.36)	.342
30.0–34.9	1.34 (1.04–1.76)	.071
≥35.0	1.84 (1.32–2.58)	.001
Prior termination	0.72 (0.55–0.95)	.021
Smoking during pregnancy (>5 cigarettes/day)	1.35 (1.05–1.74)	.030
Placenta previa/low lying placenta	4.57 (3.34–6.27)	<.001
Placental abruption	3.60 (2.37–5.45)	<.001

OR = Odds ratio.

that only nulliparity, prior termination, obesity, infertility problems, placenta previa, and maternal smoking during pregnancy were independent risks for VCI (Table 2).

Women with VCI delivered at a significantly lower gestational age ( $P < .001$ ) and showed more commonly underwent emergency cesarean section than women with normal cord insertion ( $P < .001$ ). In the study group, the mean birth weight was significantly lower than that in the reference population (3278.0 g vs 3496.4 g,  $P < .001$ ; Table 3). After adjusting the confounding factors, VCI was significantly associated with increased risks of adverse pregnancy outcomes (1.83-fold), risks of admission to a neonatal unit (2.58-fold), preterm delivery (3.62-fold), LBW, and SGA (1.41-fold) than the women with normal cord insertion (Table 4). Further, the risk of VCI was 25% lower (adjusted OR 0.75, 95% CI 0.67–0.94) in multiparous women compared to nulliparous counterparts ( $P = .003$ ).

Among the 501 perinatal fetuses with velamentous placenta, there were 7 perinatal deaths including 1 with vessel rupture in a case of vasa praevia, 3 with LBW, 1 with torsion of cord, and 1 with placental abruption (Table 5). One (1/501) showed concurrent vessel rupture in vasa praevia who was admitted to the hospital at a gestational age of 37<sup>+</sup> weeks combined with vaginal hemorrhage for 1 hour with a volume of 100 ml. The fetal heart was about 60 bpm per min, and then cesarean section was conducted with the 1-minute, 5-minute, and 10-minute Apgar score of 1, 4, and 5, respectively. The fetus died 6 hours after delivery. Pathological analysis revealed severe anoxia and

**Table 3**  
**Pregnancy and delivery characteristics and delivery interventions in women with VCI and those with normal umbilical cord insertion.**

Characteristics	Women with VCI (n=501)	Women with normal cord insertion (n=59475)	P value
Mean gestational age	38.4 ± 2.8	39.4 ± 2.1	<.001
Cesarean (pooled)	23.8	16.1	<.001
Elective	6.9	7.0	.991
Emergency	16.1	8.9	<.001
Forceps delivery	9.1	8.3	.476
Birth weight	3278.0 ± 755.4	3496.4 ± 593.1	<.001
Malformation	4.8	3.9	.306

insertion of umbilical cord onto the fetal membrane, together with vessel rupture on the branch of umbilical artery (Figs. 1 and 2).

#### 4. Discussion

Among the total population of women with singleton pregnancies delivered in Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital during the study period between January 2004 and January 2014, the prevalence of VCI was 0.84%. Independent risk factors of VCI were nulliparity, obesity, infertility problems, placenta previa, and maternal smoking during pregnancy, whereas, prior termination was associated with protection against VCI. Pregnancies complicated by VCI were associated with 1.4- to 3.6-fold greater risks of prematurity, LBW, and SGA compared with women presenting normal cord insertion. Impaired fetal growth and prematurity were associated with higher rates of cesarean deliveries and admissions to a neonatal unit.

The prevalence of VCI among the study population was 0.84%; this figure was similar to reported in previous studies.<sup>[11]</sup> Maternal obesity and fertility problems were associated with an increased prevalence of VCI, which were known to be in constant increase in our catchment area and may thus explain the changes in the prevalence of VCI.<sup>[12,13]</sup> The mechanism linking obesity and abnormal insertion was beyond the scope of the present study, but maternal obesity may lead to alterations in placental development or function.<sup>[14]</sup> Negative effects of obesity on fertility<sup>[15]</sup> and increased use of infertility treatments might

**Table 4**  
**Perinatal outcomes among infants with VCI and with normal umbilical cord insertion (n=59976).**

Outcome	Women with velamentous cord insertion (%)	Women with normal cord insertion (%)	Unadjusted OR (95%CI)	Adjusted OR (95% CI)
Prematurity (delivery wks <37) <sup>*†</sup>	14.2	5.9	2.63 (2.04–3.39) <sup>  </sup>	2.58 (1.93–3.12) <sup>  </sup>
Admission to a neonatal unit	16.8	9.2	1.99 (1.57–2.52) <sup>  </sup>	1.83 (1.36–2.51) <sup>§</sup>
Fetal death	0.8	0.4	2.00 (0.74–5.40)	1.58 (0.72–4.98)
LBW (<2500 g) <sup>†</sup>	15.2	4.6	3.71 (2.90–4.75) <sup>  </sup>	3.62 (2.82–4.56) <sup>  </sup>
SGA (<90th percentile) <sup>†</sup>	14.8	10.3	1.51 (1.18–1.93) <sup>§</sup>	1.41 (1.12–1.83) <sup>§</sup>
Low Apgar score (<7 at 1 min)	7.6	5.1	1.53 (1.10–2.13) <sup>‡</sup>	1.23 (0.79–1.97)
Low Apgar score (<7 at 5 min)	3.6	2.4	1.52 (0.94–2.43)	1.42 (0.88–2.28)

LBW = low birth weight, SGA = small-for-gestational age.

\* Not adjusted for gestational age.

† Not adjusted for birth weight.

‡  $P \leq .05$ .

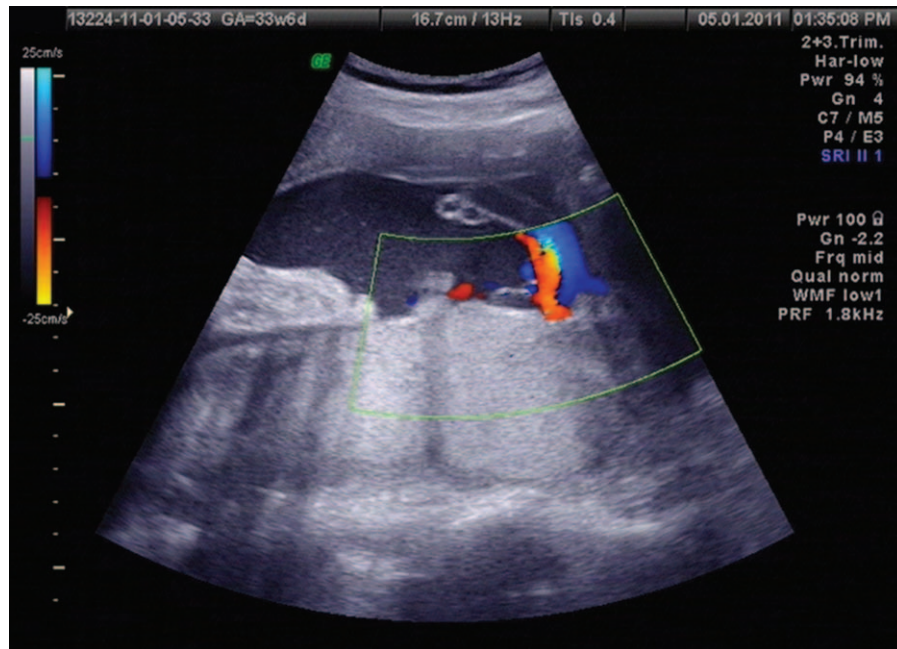
§  $P \leq .01$ .

||  $P \leq .001$ .

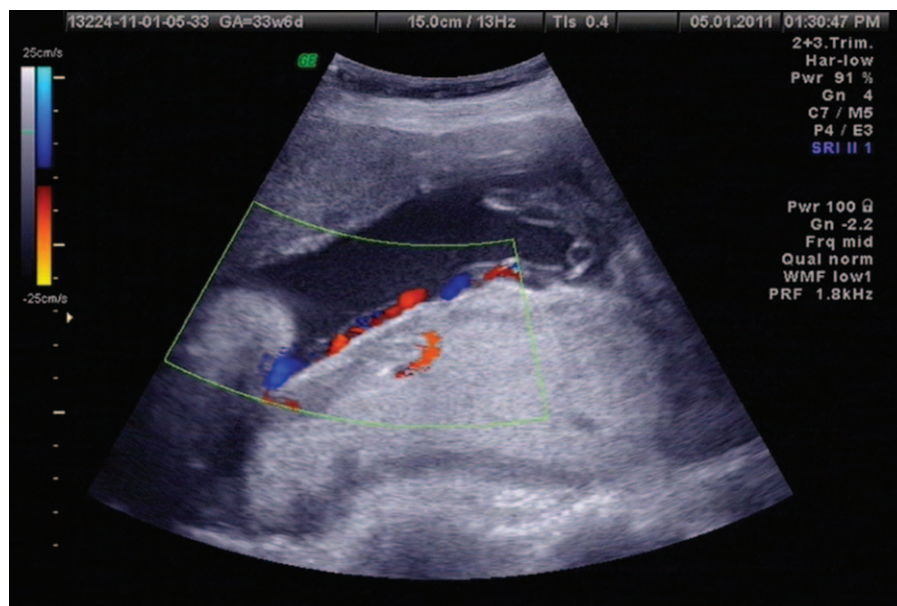
<b>Table 5</b>		
<b>Causes for perinatal mortality in the velamentous placenta.</b>		
<b>Cause</b>	<b>N</b>	<b>%</b>
Rupture of vasa praevia	1	14.3
Low birth weight	3	42.9
Exaggerated torsion of umbilical cord	1	14.3
Prolapse of umbilical cord	1	14.3
Placental abruption	1	14.3
Total	7	100

explain a higher incidence of women with VCI and fertility problems, as well as less frequent prior terminations. Furthermore, pregnancies conceived through ART have been shown to predispose to low lying placentas and abnormal insertions compared to naturally conceived pregnancies,<sup>[1]</sup> probably due to uterine contractions induced by the embryo placement catheter.

Our results confirmed the association between adverse pregnancy outcomes and VCI that had been found in previous studies.<sup>[6,9]</sup> Consequently, our results confirmed that VCI increased the risk of preterm delivery, LBW, SGA, and the necessity for surveillance in a neonatal unit. The association



**Figure 1.** Color Doppler ultrasonography indicated entry of umbilical vessels into the placental parenchyma.



**Figure 2.** Color Doppler ultrasonography indicated distribution of umbilical vessels on the fetal membrane.

between fetal death and VCI appeared to be insignificant in both the univariate and multivariate analyses. This may be related to the low prevalence of cases. Overall, the outcomes may not change dramatically even though we have witnessed substantial developments in the assessment of fetal well-being.

The most important strength of the present study was that the data covered the entire population delivered between 2004 and 2014 in Qinhuangdao Maternal and Child Health Hospital and Qinhuangdao Beidaihe Hospital. On the other hand, the results gave an optimistic picture of the impact of VCI on pregnancy outcomes, since first and second trimester miscarriages were not included in the data.

In conclusion, VCI impaired fetal growth and resulted in preterm deliveries, increased the necessity for cesarean deliveries and care in the neonatal intensive care unit. VCI was more common in nulliparous women, smokers, and obese women, and in women with fertility problems and those with no prior terminations. Excess weight, obesity, and smoking were modifiable risk factors and therefore advocated weight reduction for obese women who want to become pregnant and smoking cessation may be advisable.

### Author contributions

**Conceptualization:** Mo Yang, Yanqiu Zheng.

**Data curation:** Mo Yang, Yanqiu Zheng, Jing Zhang, Fuqing Zhou.

**Formal analysis:** Mo Yang, Yanqiu Zheng, Fuqing Zhou.

**Funding acquisition:** Mingjing Li, Fuqing Zhou, Qing Yang.

**Investigation:** Mingjing Li, Jing Zhang, Qing Yang.

**Methodology:** Mingjing Li, Wei Li, Qing Yang.

**Project administration:** Wei Li.

**Resources:** Wei Li, Xu Li.

**Software:** Xu Li, Xinhua Zhang.

**Supervision:** Xu Li, Xinhua Zhang, Ruihua Wang.

**Validation:** Xu Li, Xinhua Zhang, Ruihua Wang.

**Visualization:** Xinhua Zhang, Ruihua Wang.

**Writing – original draft:** Mo Yang.

**Writing – review & editing:** Gang Li.

### References

- [1] Delbaere I, Goetgeluk S, Derom C, et al. Umbilical cord anomalies are more frequent in twins after assisted reproduction. *Hum Reprod* 2007;22:2763–7.
- [2] Hasegawa J, Matsuoka R, Ichizuka K, et al. Velamentous cord insertion into the lower third of the uterus is associated with intrapartum fetal heart rate abnormalities. *Ultrasound Obstet Gynecol* 2006;27:425–9.
- [3] Hasegawa J, Matsuoka R, Ichizuka K, et al. Velamentous cord insertion: significance of prenatal detection to predict perinatal complications. *Taiwan J Obstet Gynecol* 2006;45:21–5.
- [4] Hasegawa J, Matsuoka R, Ichizuka K, et al. Atypical variable deceleration in the first stage of labor is a characteristic fetal heart-rate pattern for velamentous cord insertion and hypercoiled cord. *J Obstet Gynaecol Res* 2009;35:35–9.
- [5] Heinonen S, Taipale P, Saarikoski S. Weights of placentae from small-for-gestational age infants revisited. *Placenta* 2001;22:399–404.
- [6] Heinonen S, Ryyanen M, Kirkinen P, et al. Perinatal diagnostic evaluation of velamentous umbilical cord insertion: clinical, Doppler, and ultrasonic findings. *Obstet Gynecol* 1996;87:112–7.
- [7] Toivonen S, Heinonen S, Anttila M, et al. Reproductive risk factors, Doppler findings, and outcome of affected births in placental abruption: a population-based analysis. *Am J Perinatol* 2002;19:451–60.
- [8] Hasegawa J, Farina A, Nakamura M, et al. Analysis of the ultrasonographic findings predictive of vasa previa. *Prenat Diagn* 2010;30:1121–5.
- [9] Eddleman KA, Lockwood CJ, Berkowitz GS, et al. Clinical significance and sonographic diagnosis of velamentous umbilical cord insertion. *Am J Perinatol* 1992;9:123–6.
- [10] Papinniemi M, Keski-Nisula L, Heinonen S. Placental ratio and risk of velamentous umbilical cord insertion are increased in women with placenta previa. *Am J Perinatol* 2007;24:353–7.
- [11] Sepulveda W, Rojas I, Robert JA, et al. Prenatal detection of velamentous insertion of the umbilical cord: a prospective color Doppler ultrasound study. *Ultrasound Obstet Gynecol* 2003;21:564–9.
- [12] Raatikainen K, Heiskanen N, Heinonen S. Transition from overweight to obesity worsens pregnancy outcome in a BMI-dependent manner. *Obesity (Silver Spring)* 2006;14:165–71.
- [13] Terava AN, Gissler M, Hemminki E, et al. Infertility and the use of infertility treatments in Finland: prevalence and socio-demographic determinants 1992–2004. *Eur J Obstet Gynecol Reprod Biol* 2008;136:61–6.
- [14] Hayes EK, Lechowicz A, Petrik JJ, et al. Adverse fetal and neonatal outcomes associated with a life-long high fat diet: role of altered development of the placental vasculature. *PLoS One* 2012;7:e33370.
- [15] Arendas K, Qiu Q, Gruslin A. Obesity in pregnancy: pre-conceptional to postpartum consequences. *J Obstet Gynaecol Can* 2008;30:477–88.