Placenta 85 (2019) 69–73

Contents lists available at ScienceDirect

Placenta

journal homepage: www.elsevier.com/locate/placenta

Are maternal and neonatal outcomes different in placental abruption between women with and without preeclampsia?

Min Han[a], Dan Liu[a], Shahn Zeb[b], Chunfang Li[a], Mancy Tong[c], Xuelan Li[a,**], Qi Chen[d,e,*]

[a] Department of Obstetrics & Gynaecology, First affiliated hospital of Xi'an Jiaotong University, China
[b] Xi'an Jiaotong University, Xi'an, China
[c] Department of Obstetrics, Gynecology and Reproductive Sciences, Yale School of Medicine, New Haven, CT, USA
[d] The Hospital of Obstetrics & Gynaecology, Fudan University China, China
[e] Department of Obstetrics & Gynaecology, The University of Auckland, New Zealand

ARTICLE INFO

Keywords:
Placental abruption
Preeclampsia
Maternal fetal and neonatal outcomes

ABSTRACT

Introduction: Placental abruption is a serious pregnancy complication that causes maternal and neonatal mortality and morbidity. Whether maternal and neonatal outcomes differ between patients who concurrently presented with preeclampsia and those who did not, have not been fully investigated.

Methods: A total number of 158 patients with placental abruption were included. Of them, 66 concurrently had preeclampsia. Maternal and neonatal characteristics including delivery weeks, time of onset and birthweight as well as the grade of placental abruption were collected and analysed.

Results: The time at diagnosis of placental abruption in patients who concurrently presented preeclampsia was significantly earlier than that in patients who did not. The number of patients with grade III placental abruption was significantly higher in patients who concurrently presented with preeclampsia, compared to patients who did not. The odds ratio of an increase in grade III placental abruption in patients who concurrently presented preeclampsia was 5.27 (95%CL: 2.346, 12.41), compared to patients who did not. The numbers of infants who were born pre-term and the numbers of stillbirth/neonatal deaths as well as the number of fetal distress were significantly higher in patients who concurrently presented with preeclampsia, compared to patients who did not. The fetal birthweight was significantly lower in patients who concurrently presented with preeclampsia compared to patients who did not.

Discussion: Our study demonstrates that women with preeclampsia experiencing placental abruption had worse maternal, fetal and neonatal outcomes, compared to women experiencing placental abruption alone.

1. Introduction

Placental abruption occurs in approximately 0.2–1% of all pregnancies around 25 weeks of gestation and is a significant cause of maternal and neonatal mortality and morbidity, in particular when it occurs preterm [1]. Placental abruption contributes to about 15% of infant deaths around the time of birth [1], although maternal deaths due to placental abruption are rare in western countries.

The causes of placental abruption are still not entirely clear, but risk factors include a history of preeclampsia, caesarean section or preterm premature rupture of membranes, advanced maternal age and multiparity [1]. One study reported that women with previous preeclampsia had up to a 5-fold risk of developing placental abruption, depending on the severity of previous preeclampsia [1,2]. In addition, the incidence of placental abruption in women who concurrently presented with severe preeclampsia was 3% [3].This is because placental abruption and preeclampsia have the similar pathogenesis such as placental ischaemia [4–6].

A large number of studies have investigated the maternal and neonatal outcomes in women with placental abruption. However, only limited studies have compared whether there are any differences in maternal and neonatal outcomes in women who had placental abruption and concurrently had preeclampsia or hypertension [7,8]. These studies found that overall there was no difference in neonatal outcomes between normotensive and hypertensive women who had abrupted placentae, although hypertensive women with abrupted placentae were more likely to experience higher-grade abruption [7,8]. A recent study reported on the incidence of maternal mortality after placental

* Corresponding author. The Hospital of Obstetrics & Gynaecology, Fudan University China.
** Corresponding author.
E-mail addresses: lixuelan1225@126.com (X. Li), q.chen@auckland.ac.nz (Q. Chen).

https://doi.org/10.1016/j.placenta.2019.07.003
Received 30 March 2019; Received in revised form 30 June 2019; Accepted 4 July 2019

abruption in women with hypertension, but that study did not compare the difference in other maternal outcomes between women with and without hypertension [9]. Only a few studies have examined differences in maternal outcomes between hypertensive and normotensive women with placental abruption, demonstrating no difference [8,10]. However, to our knowledge no study has examined the effect of preeclampsia, which is associated with poorer maternal and neonatal outcomes than gestational hypertension, on maternal mortality from placental abruption.

Therefore, in this retrospective study we investigated the difference in maternal and neonatal outcomes in women with placental abruption in the present or absence of preeclampsia.

2. Material and methods

This investigation conforms to the principles outlined in the Declaration of Helsinki. This retrospective study received the approval from the Ethics Committee of the First Hospital of Xi'an Jiaotong University, Shan'xi Province of China.

2.1. Study population

This retrospective study was conducted in a tertiary teaching hospital in Xi'an city of China. From May 2013 to December 2018, there were 158 pregnant women who were diagnosed with placental abruption and delivered in this hospital. Of these, 66 patients had preeclampsia at the time of presentation of placental abruption. During the study period, there were 17,055 live births in our hospital. Data on maternal age, parity and gravida, previous preeclampsia, placental abruption and mode of delivery, delivery week, and birthweight were collected. In addition, the number of patients with vaginal bleeding, abdominal pain, postpartum haemorrhage and fetal complication including fetal distress were also collected.

Placental abruption was defined by the premature detachment of the placenta from the uterine wall, after 20 weeks of gestation and before birth according to the guideline [11]. The criteria for diagnosis of placental abruption included sonographic visualization of abruption, evidence of retro-placental clots, or vaginal bleeding or abdominal pain accompanied by nonreassuring fetal status or uterine hypertonicity described by previous study [12]. Placental abruption was confirmed by retro-placental hematoma seen by the naked eye after delivery [13]. The classification of placental abruption was divided into three grades based on the severity of abruption. Grade 1: small amount of vaginal bleeding, some uterine contractions without signs of fetal distress or low blood pressure in the mother. Grade 2: mild to moderate amount of bleeding, uterine contractions and fetal distress. Grade 3: moderate to severe bleeding or concealed (hidden) bleeding, uterine contractions that do not relax (tetany), abdominal pain, low blood pressure in the mother and fetal death.

Severe placental abruption was defined by one of the following criteria that was recently recommended [14]: 1) maternal complications including blood transfer, hysterectomy, renal failure, disseminated intravascular coagulations, hypovolemic shock and in hospital death. 2) Fetal or neonatal complications including nonreassuring fetal status, intrauterine growth restriction, fetal death, neonatal death, preterm delivery and small for gestational age (SGA).

Preeclampsia was defined as a maternal systolic blood pressure $\geq$140 mmHg and/or diastolic blood pressure $\geq$90 mmHg measured on two occasions separated by at least 6 h, and proteinuria > 300 mg in a 24 h period, or impaired liver function and lower platelet count, after 20 weeks of gestation in accordance with guidelines of the International Society for the Study of Hypertension in Pregnancy (ISSHP) in 2018 [15]. Maternal systolic blood pressure $\geq$160 mmHg and/or diastolic blood pressure $\geq$110 mmHg was defined as severe preeclampsia. Preeclampsia occurring earlier than 34 weeks of gestation was defined as early-onset.

Small for gestational age (SGA) was defined birthweight under 10th percentile using the WHO fetal growth chart based on the gestational age, adjusted for ethnicity [16].

In our tertiary hospital, prenatal care starts as early as 12 weeks of gestation. The time for prenatal check (every two weeks or four weeks) is dependent on gestational age. But for women with high risk such as history of preeclampsia, we ask them coming every week or every two weeks. If it is a severe case, we ask them to stay in the hospital for more closely monitor.

2.2. Statistical analysis

Data were presented as median and range or mean and standard deviation (SD) or number or percentage as appropriate. The statistical differences in maternal age, blood pressure, gestational week at diagnosis, gestational week at delivery and birthweight between patients who concurrently present with preeclampsia and those who did not were assessed by the Mann-Whitney *U* test using the Prism software package. The statistical differences in number of stillbirth/neonatal death, grades of placental abruption, history of preeclampsia and placental abruption, previous live birth(s), blood transfer, postpartum haemorrhage, fetal distress, SGA and admission to NICU were assessed by chi-square test or Fisher's exact test between patients who concurrently presented with preeclampsia and those who did not using the Prism software package. P-values of < 0.05 were considered significant.

3. Results

3.1. Clinical characteristics of the study population

The incidence of placental abruption was 0.93% of in live births in our study cohort. The median age of patients was 31 (range 19–46) years. 93 (59%) women had more than two pregnancies. 66 (42%) women had a previous live birth. Of the 158 patients, 66 (42%) patients had preeclampsia at the time of presentation of placental abruption. Of these 66 patients, 58 (87%) developed early onset preeclampsia, and 7 (10.6%) had a history of preeclampsia. The clinical characteristics of patients who concurrently presented with preeclampsia and those who did not are summarised in Table 1. There was no difference in maternal age and gravidity between patients who concurrently presented with preeclampsia and those who did not (Table 1, $p = 0.708$, or $p = 0.193$ respectively), but a significant higher numbers of patients who had previous live birth(s) who concurrently presented with preeclampsia, compared to those who did not (Table 1, $p = 0.033$). There were no women with a history of preeclampsia in the group of patients who did not concurrently presented with preeclampsia. While seven patients who concurrently presented with preeclampsia had history of preeclampsia, only one patient had history of placental abruption in both the group of patients who concurrently presented with preeclampsia and those who did not.

3.2. Patients with preeclampsia at the time of presentation of placental abruption had worse maternal outcomes

The mean time of diagnosis of placental abruption in patients who concurrently presented with preeclampsia was significantly earlier than those who did not have preeclampsia (31 vs 35 weeks of gestation, $p < 0.0001$, Table 2). However, there was no difference in the number of patients who were diagnosed with placental abruption before delivery, or at the time of labour, between patients who concurrently presented with preeclampsia and those who did not (Table 2, $p = 0.295$). The number of patients who had vaginal bleeding and abdominal pain was significantly higher in patients who did not concurrently present with preeclampsia (Table 2, $p = 0.010$, or $p = 0.005$, respectively). There was no difference in the number of patients who

Table 1
The differences in clinical characteristics between patients with and without presentation of preeclampsia.

Maternal age (years, median/range)	Placental abruption without PE (n = 92)	Placental abruption with PE (n = 66)	P value
	31 (21–45)	30 (19–46)	P = 0.708
Gravida (number, column %)			
N = 1	42 (46%)	23 (35%)	P = 0.193
N ≥ 2	50 (54%)	43 (65%)	
Systolic blood pressure (mmHg, mean ± SD)	117 ± 10	152 ± 15	**p < 0.001**
Diastolic blood pressure (mmHg, mean ± SD)	76 ± 7	100 ± 17	**p < 0.001**
History of PE (number, %)	0 (0%)	7 (10.6%)	N/A[a]
History of placental abruption (number, %)	1(2%)	1 (2.5%)	N/A[a]
Previous live birth (number, %)	30 (32.6%)	33 (50%)	**P = 0.033**

PE: preeclampsia.
[a] Not applicable due to small sample size.

had blood transfer, postpartum haemorrhage, or admission to ICU between patients who concurrently presented with preeclampsia and those who did not (Table 2, p = 0.454, or p = 0.174, or p = 0.279, respectively).

In relation to the grades of placental abruption, the number of patients with grade III placental abruption was significantly higher in patients who concurrently presented with preeclampsia, compared to patients who did not (36% vs 10%, Table 2, p = 0.0002). The odds ratio of an increase in grade III placental abruption in patients who concurrently presented with preeclampsia was 5.27 (95%CL: 2.346, 12.41, p = 0.0001, Table 3), compared to patients who did not concurrently present with preeclampsia.

3.3. Patients with preeclampsia at the time of presentation of placental abruption had worse neonatal outcomes

There were 35 (53%) stillbirth/neonatal deaths in patients who concurrently presented with preeclampsia and placental abruption, which was significantly higher than that in patients who did not (14 patients, 15%, p < 0.0001). In patients with a live birth, the mean birthweight was significantly lower in patients who concurrently presented with preeclampsia compared to patients who did not (1727 ± 522 compared with 2810 ± 792, Table 4, p < 0.0001). Significantly more infants were born before 37 weeks (pre-term) to patients who concurrently presented with preeclampsia, compared to patients who did not (Table 4, p < 0.0001). In addition, the numbers of SGA infants and the numbers of infants who had fetal distress or were admitted to neonatal intensive care unit (NICU) were significantly higher in patients who concurrently presented with preeclampsia and placental abruption, compared to patients who presented with placental abruption only (Table 4, p < 0.0001 or p = 0.0159, or p < 0.0001, respectively). The odds ratio of an increase in SGA in patients who concurrently presented with preeclampsia and placental abruption was 23.12 (95%CL: 7.2555, 73.66), compared to those who did not have preeclampsia. The odds ratio of an increase in NICU admission in patients who concurrently presented with preeclampsia and placental abruption was 27.39 (95%CL: 6.07, 123.6), compared to those who did not have preeclampsia.

3.4. Severity of placental abruption

Based on the recent definition of severe placental abruption [14], we found that 64/66 (97%) patients who concurrently presented with preeclampsia experienced severe placental abruption, which was significantly greater than the 54/92 patients (58%) who presented with severe placental abruption in the group without pre-eclampsia (p < 0.0001). The odds ratio of an increase in severe placental abruption in patients who concurrently presented with preeclampsia was 22.52 (95%CL: 5.192, 97.67), compared to those who did not have preeclampsia.

4. Discussion

In this retrospective study spanning six years with a medium sample size, we found that the incidence of placental abruption was 0.93% in all live births in our study population. Women with preeclampsia experiencing placental abruption are more likely to be diagnosed earlier, be delivered earlier, and have a higher grade of placental abruption. In addition, the neonatal birthweight was significantly lower and the number of SGA infants was significantly higher in patients who concurrently presented with preeclampsia and placental abruption, compared to patients who did not have preeclampsia.

Table 2
The differences in maternal outcomes between patients with and without presentation of preeclampsia.

	Placental abruption without PE (n = 92)	Placental abruption with PE (n = 66)	P value
Delivery weeks (mean ± SD)	$35^{\pm 3} \pm 5.0$	$31^{\pm 2} \pm 4.4$	p < 0.0001
Vaginal bleeding (number, %)	69 (75%)	36 (55%)	P = 0.010
Abdominal pain (number, %)	64 (70%)	31 (47%)	P = 0.005
Abruption grade (number, %)			
Grade I	59 (64%)	26 (40%)	P = 0.0002
Grade II	24 (26%)	16 (24%)	
Grade III	9 (10%)	24 (36%)	
Time of diagnosis			
(weeks, mean ± SD)	$35^{+2} \pm 5.3$	$31^{+1} \pm 4.5$	p < 0.0001
Diagnosis before delivery (number, %)	60 (65%)	49 (75%)	P = 0.295
Diagnosis at the time of labour (number, %)	32 (35%)	17 (25%)	
Blood transfer (number, %)	20(22%)	18 (27%)	P = 0.454
Postpartum haemorrhage (number, %)	7 (7.6%)	9 (14%)	N/A[a]
Admission to ICU (number, %)	3 (3%)	5 (7.5%)	N/A[a]

PE: preeclampsia; ICU: Intensive care unit.
[a] Not applicable due to small sample size.

Table 3
Odds ratio of having grade III placental abruption between patients with and without presentation of preeclampsia.

	Placental abruption without PE (n = 51)	Placental abruption with PE (n = 40)	Odds Ratio	95% CL	P value
Grade I & II (reference)	83 (90.2%)	42 (63.6%)	–	–	–
Grade III	9 (9.8%)	24 (36.4%)	5.27	2.346, 12.41	P = 0.0001

To date studies investigating the maternal and neonatal outcomes in women with and without preeclampsia who had placental abruption are very limited, and have a small sample size (under 30 cases with preeclampsia and placental abruption). Furthermore, there is considerable variation in the incidence of placental abruption across countries and different regions [17]. To date, studies investigating the incidence of placental abruption in the Chinese population is limited. In our current study, we analysed the maternal and neonatal outcomes in women with (n = 66) and without preeclampsia (n = 92) who experienced with placental abruption.

A recent study reported that the incidence of placental abruption varied from 0.3% to 1% in the United States and European countries [17]. In our current study, consistent with a previous study on the Chinese population [18], we found a similar incidence of 0.93%.

Hypertensive women with placental abruption were likely to have a higher grade (grade II and III) of placental abruption [7]. However, a previous study reported no difference in the grade of placental abruption between patients who concurrently presented with preeclampsia and patients who did not [10]. In our current study, we found that the odds ratio of having a grade III placental abruption was 5.27 (95%CL: 2.346, 12.41) in patients who concurrently presented with preeclampsia, compared with patients who did not, and this is consistent with previous findings [7]. However, previous studies did not report any difference in gestational age at delivery between women with placental abruption with or without preeclampsia [7,8]. In contrast, in our larger study, we found that preeclamptic women who had placental abruption delivered significantly earlier. In addition, the incidence of pre-term labour was also significantly higher in preeclamptic women who had placental abruption. The difference in delivery week between our current study and others could be because of the sample size and patients' characteristics. In our current study, 66 preeclamptic women with placental abruption were included, while in other studies, only 22 or 29 hypertensive women including gestational hypertension, preeclampsia and eclampsia with placental abruption were included. It is well-known that there are differences in maternal and neonatal outcomes between gestational hypertension, preeclampsia and eclampsia. In addition, while in other studies they did not break down the subtypes of preeclampsia, in our current study the majority of preeclampsia (87%) was early onset form which could be a confounder affecting maternal outcomes. Taken together, our findings suggest that women with preeclampsia had worse maternal clinical outcomes during placental abruption compared to women without preeclampsia.

Vaginal bleeding in the later part of pregnancy and abdominal pain are two of the most common clinical symptoms of placental abruption [19]. In our current study, we found that more normotensive women who experienced placental abruption had vaginal bleeding and abdominal pain, compared with preeclamptic women who experienced placental abruption. However, the number of patients with grade III abruption and the number of severe placental abruptions were significantly higher in the preeclamptic group. We do not know the exact reasons but this could be explained by 1) preeclampsia and placental abruption are associated with placental ischemia, resulting in consequently share many similar pathological features [4–6,20]. The failure to delivery adequate oxygen to the placenta could worse both maternal and fetal/neonatal wellbeing [20]. In addition, women with ischemic placental diseases in the first pregnancy are at substantially increased risk of recurrence of similar complications in subsequent pregnancy [21,22]. Parker et al. reported that preterm placental abruption in previous pregnancy significantly increased the risk for developing preeclampsia in second pregnancy [21]. 2) ultrasound was more frequently performed in women with preeclampsia resulting in an early diagnosis. 3) although the time at diagnosis of placental abruption was significantly earlier in preeclamptic women who experienced placental abruption, preeclampsia may have a rapid effect on the progression of placental abruption before the presentation of vaginal bleeding and abdominal pain, as the majority of patients with preeclampsia experienced early onset preeclampsia. 4) the underlying mechanism of placental abruption may be different between patients with and without preeclampsia. This needs to be investigated in the future.

Although some studies reported that there was no difference in fetal and neonatal outcomes between preeclamptic and normotensive women who had placental abruption [7,8], in our current study, we found that neonatal birthweight was significantly lower and the number of SGA infants was significantly higher in preeclamptic women who had placental abruption, compared to normotensive women who had placental abruption. This difference could also be because of our larger sample size and higher number of early onset preeclampsia cases. We also found a significantly higher rate of fetal distress and NICU admission in preeclamptic women who experienced placental abruption, compared to normotensive women. This could be because that both preeclampsia and placental abruption are major contributions of fetal distress (reviewed in Ref. [23]). In addition, in our current study we also found that the number of pre-term birth in preeclamptic women who had placental abruption was 87%, which was significantly higher than that in normotensive women who had placental abruption. While the number of pre-term births (58%) in normotensive women who had placental abruption in our current study was consistent with previous data [1]. Furthermore, in our study, the number of stillbirths/neonatal deaths was significantly higher in preeclamptic women who had placental abruption, compared to normotensive women who experienced placental abruption (56% vs 15%). Taken together, our findings suggest that fetal and neonatal adverse outcomes were severe in infants who were born by preeclamptic women who had placental abruption.

There are some limitations in this study. Firstly, the data were

Table 4
The differences in fetal and neonatal outcomes between patients with and without presentation of preeclampsia with a live birth.

	Placental abruption without PE (n = 78)	Placental abruption with PE (n = 31)	P value
SGA (number, %)	5 (6%)	19 (61%)	p < 0.0001
Admission to NICU (number, %)	27 (35%)	29 (93%)	p < 0.0001
Birthweight (g, mean ± SD)	2810 ± 792	1727 ± 522	p < 0.0001
Pre-term birth (number, %)	33 (42%)	27 (87%)	p < 0.0001
Fetal distress (number, %)	12 (13%)	19 (28%)	P = 0.0159

NICU: neonatal intensive care unit; PE: preeclampsia.

collected from one tertiary hospital in China, which may not be able to representative to the whole of Chinese population. Whether there are variations between the ethnicities or regions should be investigated in a multi-centres worldwide in future. Secondly, due to the sample size, our current study is not powered to study the different subsets of pre-eclampsia and their contributions to risks of abruption. Future international collaborative studies should be established to confirm our current findings and better characterise conditions of placental abruption.

In conclusion, our retrospective study demonstrates that women with preeclampsia experiencing placental abruption had worse maternal, fetal and neonatal outcomes, compared to women experiencing placental abruption only. Our study also found that placental abruption was more severe in patients with preeclampsia. Our findings suggest that clinical recommendations for close monitoring of women with preeclampsia is important, especially when placental abruption is diagnosed. In addition, close monitoring women with history of these complications in subsequent pregnancies should be recommended.

Declaration of interest

None of authors have a conflict of interest.

Acknowledgements

This study was supported by Shanxi Province Science and Technology Development project, China (Grant number 2015SF124) and Shanxi Province International collaborative program (Grant number 2016KW-006). All authors thank Dr. Joana James, a native English speaker from the University of Auckland to edit this manuscript.

References

[1] M. Tikkanen, Placental abruption: epidemiology, risk factors and consequences, Acta Obstet. Gynecol. Scand. 90 (2) (2011) 140–149.
[2] N.B. Kyrklund-Blomberg, G. Gennser, S.J.P. Cnattingius, P. Epidemiology, Placental abruption and perinatal death 15 (3) (2010) 290–297.
[3] B.M. Sibai, B.M. Mercer, E. Schiff, S.A. Friedman, Aggressive versus expectant management of severe preeclampsia at 28 to 32 weeks' gestation: a randomized controlled trial, Am. J. Obstet. Gynecol. 171 (3) (1994) 818–822.
[4] K.P. Conrad, D.F. Benyo, Placental cytokines and the pathogenesis of preeclampsia, Am. J. Reprod. Immunol. 37 (3) (1997) 240–249.
[5] C.V. Ananth, J.C. Smulian, A.M. Vintzileos, Ischemic placental disease: maternal versus fetal clinical presentations by gestational age, J. Matern. Fetal Neonatal Med. 23 (8) (2010) 887–893.
[6] R.L. Naeye, Pregnancy hypertension, placental evidences of low uteroplacental blood flow, and spontaneous premature delivery, Hum. Pathol. 20 (5) (1989) 441–444.
[7] M.A. Morgan, K.M. Berkowitz, S.J. Thomas, P. Reimbold, E.J. Quilligan, Abruptio placentae: perinatal outcome in normotensive and hypertensive patients, Am. J. Obstet. Gynecol. 170 (6) (1994) 1595–1599.
[8] S. Furukawa, H. Sameshima, T. Ikenoue, M. Ohashi, Y. Nagai, Is the perinatal outcome of placental abruption modified by clinical presentation? J Pregnancy 2011 (2011) 659615.
[9] S. Mukherjee, A.K. Bawa, S. Sharma, Y.S. Nandanwar, M. Gadam, Retrospective study of risk factors and maternal and fetal outcome in patients with abruptio placentae, J. Nat. Sci. Biol. Med. 5 (2) (2014) 425–428.
[10] S. Munim, N. Chaudhury, K. Jamal, F.A. Khan, Outcome of abruptio placentae in normotensive and hypertensive patients in Aga Khan University Hospital, Pakistan, J. Obstet. Gynaecol. Res. 23 (3) (1997) 267–271.
[11] K.L. Downes, K.L. Grantz, E.D. Shenassa, Maternal, labor, delivery, and perinatal outcomes associated with placental abruption: a systematic review, Am. J. Perinatol. 34 (10) (2017) 935–957.
[12] D.A. Elsasser, C.V. Ananth, V. Prasad, A.M. Vintzileos, New Jersey-Placental Abruption Study I. Diagnosis of placental abruption: relationship between clinical and histopathological findings, Eur. J. Obstet. Gynecol. Reprod. Biol. 148 (2) (2010) 125–130.
[13] T.,. Boisramé, N.,. Sananès, G.,. Fritz, E.,. Boudier, G.,. Aissi, R.,. Favre, B. Langer, % J European Journal of Obstetrics, Gynecology, Biology R. Placental abruption: risk factors, management and maternal-fetal prognosis, Cohort study over 10 years 179 (1) (2014) 100–104.
[14] C.V. Ananth, J.A. Lavery, A.M. Vintzileos, D.W. Skupski, M. Varner, G. Saade, J. Biggio, M.A. Williams, R.J. Wapner, J.D. Wright, Severe placental abruption: clinical definition and associations with maternal complications, Am. J. Obstet. Gynecol. 214 (2) (2016) 272 e1- e9.
[15] M.A. Brown, L.A. Magee, L.C. Kenny, S.A. Karumanchi, F.P. Mccarthy, S. Saito, D.R. Hall, C.E. Warren, G. Adoyi, S. Ishaku, The hypertensive disorders of pregnancy: ISSHP classification, diagnosis & management recommendations for international practice, Pregnancy hypertension 72 (1) (2018) 24–43.
[16] T. Kiserud, G. Piaggio, G. Carroli, M. Widmer, J. Carvalho, L. Neerup Jensen, D. Giordano, J.G. Cecatti, H. Abdel Aleem, S.A. Talegawkar, A. Benachi, A. Diemert, A. Tshefu Kitoto, J. Thinkhamrop, P. Lumbiganon, A. Tabor, A. Kriplani, R. Gonzalez Perez, K. Hecher, M.A. Hanson, A.M. Gulmezoglu, L.D. Platt, The world health organization fetal growth charts: a multinational longitudinal study of ultrasound biometric measurements and estimated fetal weight, PLoS Med. 14 (1) (2017) e1002220.
[17] C.V. Ananth, K.M. Keyes, A. Hamilton, M. Gissler, C. Wu, S. Liu, M.A. Luque-Fernandez, R. Skjærven, M.A. Williams, M. Tikkanen, S. Cnattingius, An international contrast of rates of placental abruption: an age-period-cohort analysis, PLoS One 10 (5) (2015) e0125246-e.
[18] X.-L. Luo, W.-Y. Zhang, Obstetrical disease spectrum in China: an epidemiological study of 111,767 cases in 2011, Chin. Med. J. 128 (9) (2015) 1137–1146.
[19] G.J. Hofmeyr, Z. Qureshi, Preventing deaths due to haemorrhage, Best Pract. Res. Clin. Obstet. Gynaecol. 36 (2016) 68–82.
[20] J.M. Roberts, Pathophysiology of ischemic placental disease, Semin. Perinatol. 38 (3) (2014) 139–145.
[21] S.E. Parker, M.M. Werler, M. Gissler, M. Tikkanen, C.V. Ananth, Placental abruption and subsequent risk of pre-eclampsia: a population-based case-control study, Paediatr. Perinat. Epidemiol. 29 (3) (2015) 211–219.
[22] C.V. Ananth, M.R. Peltier, M.R. Chavez, R.S. Kirby, D. Getahun, A.M. Vintzileos, Recurrence of ischemic placental disease, Obstet. Gynecol. 110 (1) (2007) 128–133.
[23] S.E. Lapinsky, Acute respiratory failure in pregnancy, Obstet. Med. 8 (3) (2015) 126–132.