Objective: To explore the uterine artery and fetal umbilical artery hemodynamic change in patients with HDP. Methods: A total of 80 patients with HDP who came to our hospital from July, 2015 to July, 2016 for pregnancy examination were included in the study and served as the observation group, while 80 healthy pregnant women who came for pregnancy examination in the same period were served as the control group. The pregnant women in the two groups were performed with sequential color Doppler ultrasound at gestation 30-40 weeks. The two-dimensional ultrasound apparatus was used to detect the uterine artery and umbilical artery. PI, RI, and S/D were recorded. The fetal BPD, head girth, femur length, and abdominal girth were measured. ELISA was used to detect 8-iso-PGF₂α. The immunoturbidimetry was used to detect Cys-C and CRP. Results: The uterine artery PI, RI, and S/D in the observation group were significantly higher than those in the control group. The umbilical artery PI, RI, and S/D in the observation group were significantly higher than those in the control group. The fetal BPD, head girth, femur length, and abdominal girth in the observation group were significantly less than those in the control group. 8-iso-PGF₂α, Cys C, and CRP levels in the observation group were significantly higher than those in the control group. Conclusions: The uterine artery and umbilical artery blood flow resistance in patients with HDP are significantly elevated, which can severely affect the placental blood perfusion and fetal growth and development, while the color Doppler ultrasound can provide a non-invasive diagnosis for fetal distress in uterus.

1. Introduction

Hypertensive disorder complicating pregnancy (HDP) is a common complication in the gestation period, mostly occurring after gestation 20 weeks, with clinical manifestations of blood pressure elevation, urine protein, edema, coma, and convulsion, resulting in multiple organ failure in a severe condition, which can cause maternal and perinatal fetal death[1]. Some researches demonstrate that adoption of color Doppler ultrasound to detect the uterine artery and umbilical artery blood flow frequency spectrum of maternal-placental circulation can predict the early preeclampsia, advanced preeclampsia, and HDP. The study is aimed to explore the uterine artery and fetal umbilical artery hemodynamic change in patients with HDP.

2. Materials and methods

2.1. General materials

A total of 80 patients with HDP who came to our hospital from July, 2015 to July, 2016 for pregnancy examination were included in the study and served as the observation group, aged from 23 to 34 years old, with an average age of 26 years old; gestational week
from 37 to 40 weeks, with an average of 37 weeks; 38 had mild HDP, 28 had moderate HDP, and 14 had severe HDP. Moreover, 80 healthy pregnant women who came for pregnancy examination in the same period were served as the control group, aged from 24 to 34 years old, with an average age of 26 years old; gestational week from 37 to 40 weeks, with an average of 37 weeks. The comparison of age and gestational week between the two groups was not statistically significant ($P>0.05$).

2.2. Inclusion and exclusion criteria

The patients in the observation group were in accordance with the related diagnostic criteria of HDP\cite{3}. Exclusion criteria: (1) those who had multiple pregnancy and chronic hypertension; (2) those who were merged with preeclampsia, cardiovascular system, blood system, and endocrine system diseases; (3) those who had placenta previa and congenital fetal malformation.

2.3. Ultrasound detection

The pregnant women in the two groups were performed with sequential color Doppler ultrasound at gestation 30-40 weeks. A supine position was taken. The two-dimensional ultrasound apparatus was used to locate the bilateral uterine artery trunk in the distal branch of bilateral internal iliac artery, and umbilical cord placenta end 5 cm within the placental attachment point, with transducer frequency of 3.5 MHz, pulse sampling volume of 2 mm, and uterine artery long axis angle <60°. Three stable and consistent artery blood flow spectrums were measured. PI, RI, and S/D were recorded. The fetal BPD, head girth, femur length, and abdominal girth were measured.

2.4. Laboratory examination

The morning fasting venous blood in the two groups was collected, and centrifuged for the serum. ELISA was used to detect 8-iso-PGF$_2\alpha$. The immunoturbidimetry was used to detect Cys-C and CRP.

2.5. Statistical analysis

SPSS 19.0 software was used for the statistical analysis. The measurement data were expressed as mean ± SD, and t test was used. Chi-square test was used for the enumeration data. $P<0.05$ was regarded as statistically significant.

3. Results

3.1. Comparison of the uterine artery hemodynamics between the two groups

The uterine artery PI, RI, and S/D in the observation group were significantly higher than those in the control group ($P<0.05$). The umbilical artery PI, RI, and S/D in the observation group were significantly higher than those in the control group ($P<0.05$) (Table 1).

3.2. Comparison of the fetal BPD, head girth, femur length, and abdominal girth

The fetal BPD, head girth, femur length, and abdominal girth in the observation group were significantly less than those in the control group ($P<0.05$) (Table 2).

### Table 1.
Comparison of the uterine artery hemodynamics between the two groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>$n$</th>
<th>Uterine artery PI</th>
<th>RI</th>
<th>S/D</th>
<th>Umbilical artery PI</th>
<th>RI</th>
<th>S/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>80</td>
<td>1.22±0.07*</td>
<td>0.64±0.05*</td>
<td>3.24±0.12*</td>
<td>0.92±0.08*</td>
<td>0.62±0.05*</td>
<td>2.55±0.18*</td>
</tr>
<tr>
<td>Control</td>
<td>80</td>
<td>0.85±0.09</td>
<td>0.49±0.08</td>
<td>2.48±0.16</td>
<td>0.81±0.06</td>
<td>0.50±0.07</td>
<td>2.43±0.15</td>
</tr>
</tbody>
</table>

$P<0.05$, when compared with the control group.

### Table 2.
Comparison of the fetal BPD, head girth, femur length, and abdominal girth (cm).

<table>
<thead>
<tr>
<th>Groups</th>
<th>$n$</th>
<th>BPD</th>
<th>Head girth</th>
<th>Femur length</th>
<th>Abdominal girth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>80</td>
<td>9.05±0.53*</td>
<td>30.16±1.24*</td>
<td>6.87±0.42*</td>
<td>29.78±1.57*</td>
</tr>
<tr>
<td>Control</td>
<td>80</td>
<td>9.82±0.43</td>
<td>34.23±1.38</td>
<td>7.51±0.47</td>
<td>34.16±1.22</td>
</tr>
</tbody>
</table>

$P<0.05$, when compared with the control group.
3.3. Comparison of 8-iso-PGF$_{2\alpha}$, Cys C, and CRP levels between the two groups

8-iso-PGF$_{2\alpha}$, Cys C, and CRP levels in the observation group were significantly higher than those in the control group ($P<0.05$) (Table 3).

Table 3.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>8-iso-PGF$_{2\alpha}$ (pg/mL)</th>
<th>Cys C (mg/L)</th>
<th>CRP (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>80</td>
<td>239.56±29.84</td>
<td>1.55±0.29</td>
<td>18.35±3.29</td>
</tr>
<tr>
<td>Control</td>
<td>80</td>
<td>128.65±19.54</td>
<td>0.64±0.18</td>
<td>9.23±1.31</td>
</tr>
</tbody>
</table>

$^*P<0.05$, when compared with the control group.

4. Discussion

After the implantation of normal fertilized egg, the trophocytes begin to invade the spiral artery after 4 weeks, which is physiologically and gradually turning to large and buckling artery, and has no arterial tissue characteristics after 8 weeks[4]. Due to HDP, the physiological conversion failure of spiral artery which is regulated by the peripheral vasoactive substance, can continuously increase the vascular resistance, decrease the placental blood perfusion, reduce the trophocyte infiltration ability, cause the invasion of abnormal trophocytes, and reduce the remodeling of trophocytes to the uterine spiral arteriole, resulting in the reduced tertiary villus of placental fetal surface, reduced vascular elasticity, shrunk luminal diameter, continuously increased vascular resistance, and finally leading to the reduced uterine placental blood flow[5,6]. Some researches demonstrate that[7] due to the maternal vascular network developmental disorder in patients with HDP, the placental blood perfusion is reduced, characterized by high resistance and low relaxation by the color Doppler ultrasound, suggesting that detection of spiral artery by the color Doppler ultrasound is of great significance in predicting HDP. It is reported that[8] the uterine artery resistance in the early pregnancy can predict the early preeclampsia, which in combined with other examinations can predict the diseases with abnormal placental blood perfusion caused by trophocyte erosion damage, and can also enhance the prediction rate of advanced preeclampsia and HDP. It is also reported that[9] the increased uterine artery resistance can reflect the pathological basis of placental damage, and the color Doppler ultrasound can screen most of the high-risk patients with preeclampsia or intrauterine growth restriction, and predict the adverse outcome of pregnancy. The results in the study showed that the uterine artery PI, RI, and S/D in the observation group were significantly higher than those in the control group ($P<0.05$); the umbilical artery PI, RI, and S/D in the observation group were significantly higher than those in the control group ($P<0.05$), indicating that the uterine artery and umbilical artery blood flow resistance in patients with HDP in the later pregnancy is abnormally elevated, and detection of its hemodynamic change by the color Doppler ultrasound can timely reflect the condition.

Placenta is the only way for substance exchange between the fetus and maternity, in which the maternity can provide the necessary nutrients for fetal growth and development through the placenta, and meanwhile bring the fetal metabolism products; therefore, sufficient placental blood perfusion is extremely important for the fetal development[10]. Due to the maternal vascular network development disorder in patients with HDP, the placental blood perfusion is insufficient, resulting in long-term hypoxia and fetal growth and development restriction. The results in the study showed that the fetal BPD, head girth, femur length, and abdominal girth in the observation group were significantly less than those in the control group ($P<0.05$), indicating that HDP can affect the fetal growth and development.

8-iso-PGF$_{2\alpha}$, is the specific product of lipid peroxidation of arachidonic acid, with strong specificity, is an ideal indicator to evaluate the lipid peroxidation and oxidative stress, and can sensitively reflect in vivo oxidative stress level[12,13]. The reduced trophocyte infiltration ability can cause the placental hypoxia to induce oxidative stress and release a large amount of inflammatory cytokines, resulting in vascular endothelial damage, and finally leading to severe HDP[14]. Cys-C is an ideal indicator to reflect GFR. The diffusive glomerular capillary endothelial cell swelling is involved in the typical renal pathological characteristics in patients with HDP, with renal perfusion pressure reduced by 20% when compared with the normal pregnant women, and GFR reduced by 32%; therefore, the serum Cys-C level will be elevated[15]. The cytotoxic substances and inflammatory mediators in patients with HDP can damage the vascular endothelial cell, and reduce EDRF, thus elevating the blood pressure[16]. It is reported that CRP can damage the vascular endothelial cell, and promote the occurrence and development of HDP, while the persistent blood pressure elevation can also damage the renal vascular endothelial cell, and induce strong inflammatory reaction, resulting in the elevated CRP level in the blood[17]. The results in the study showed that 8-iso-PGF$_{2\alpha}$, Cys C, and CRP levels in the observation group were significantly higher than those in the control group ($P<0.05$),
indicating that clinical detection of serum 8-iso-PGF$_2\alpha$, Cys C, and CRP levels is beneficial for the early diagnosis of HDP.

In conclusion, the uterine artery and umbilical artery blood flow resistance in patients with HDP are significantly elevated, which can severely affect the placental blood perfusion and fetal growth and development, while the color Doppler ultrasound can provide a non-invasive diagnosis for fetal distress in uterus.

References


