

# Application of controlled hypotension in cesarean section of pregnant women with high-risk hemorrhage

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**Abstract:** To explore the application of controlled hypotension in cesarean section of pregnant women with high-risk hemorrhage. 75 cases were randomly divided into three groups: controlled hypotension Group 1 (Group H1), controlled hypotension Group 2 (Group H2) and normal blood pressure Group (Group N). The preoperative general data, intraoperative conditions, postpartum concurrent Symptoms and other indicators of all the cases in three groups were compared. The Apgar score, umbilical arterial blood gas and other indicators of the newborns were detected. There was no significant difference in the preoperative general data, Apgar score at 1 min and 5 min, the level of PH, PaO<sub>2</sub>, PaCO<sub>2</sub> among the three groups (P>0.05). The intraoperative blood transfusion volume in group H1 and group H2 decreased significantly than that in group N (P<0.05), but there was no significant difference between group H1 and group H2 (P>0.05). Compared with group H1, the red cell transfusion volume in group H2 was significantly reduced (P<0.05). There was no significant difference in other intra-operative indexes such as bleeding volume, infusion volume, patient urine volume and hospitalization days among the three groups (P>0.05). Controlled hypotension (within 5 min of MAP down to 70% of basal blood pressure) can reduce the incidence of hemorrhage and postpartum hemorrhage during cesarean section in high-risk bleeding pregnant women and which had no bad effects on the incidence of complications and umbilical arterial blood gas indicators compared with control group.

**Keywords:** Controlled hypotension, high-risk pregnancies, hemorrhage, pregnant women, caesarean section.

## INTRODUCTION

Obstetric hemorrhage and the resulting serious complications are the leading cause of maternal mortality in China (Demirci *et al.*, 2011). How to reduce the incidence of obstetric hemorrhage and its serious complications is a serious challenge for the majority of anesthesiologists and obstetrician (Oduro and Mensah, 2006). The major causes of hemorrhage in cesarean section are placenta previa, placenta accreta, uterine inertia, and coagulopathy, among which placenta previa and placenta accreta may coexist. In recent years, because of the scarred uterus, previous abortion history, and pregnant women with multiple pregnancies, the incidence of maternal placental abnormalities and uterine contractions are also increasing (Nandhakumar and Silverman, 2013). In 2007, researchers in Japan reported that the average hemorrhage volume of placental implants was 3630 ml, while the amount of placenta penetration was 12140 ml (Faiz and Ananth, 2003). When the placenta previa was combined with placenta penetration, the blood supply was extremely rich and the intraoperative blood loss could reach tens of thousands of milliliters which leads to the surgical vision difficult to expose and to operate, even to be life-threatening (Hartmann *et al.*, 2013). Therefore, it is imperative to look for techniques that are effective in reducing postpartum hemorrhage.

Controlled hypotension has great potential in reducing bleeding in cesarean section of high-risk pregnant women with bleeding (Chung *et al.*, 2011). Controlled hypotension refers to the use of drugs or techniques to artificially reduce the mean arterial pressure of the surgical patient to 70% of the basal blood pressure on the premise of ensuring the oxygen supply of important organs, so that the amount of surgical bleeding is reduced with the decrease of blood pressure to avoid the hypoxic ischemic damage of vital organs. After termination of hypotension, blood pressure can quickly return to normal without permanent organ damage (Rodrigo, 1995; Huang *et al.*, 2014).

Controlled hypotension during anesthesia has been around for decades (O'connor *et al.*, 2006). Its physiological basis is the body's self-protection mechanism. When there is a lot of bleeding, the blood pressure drops, causing the bleeding to reduce or stop (Gurol-Urganci *et al.*, 2011). Therefore, in certain specific surgeries such as spine, hip, knee, neurosurgery, liver resection, or maxilla surgery, artificial blood pressure can be reduced to reduce surgical field bleeding. Controlled hypotension was widely used in orthopedics, neurosurgery, ENT and other related surgeries, while the application in high-risk bleeding cesarean section is still lacking extensive research in depth.

At present, the strain of blood supply in hospitals at all levels has become a norm and in some seasons it has even

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reached the extent that affects normal medical activities (Zhu *et al.*, 2017). Controlled hypotension may help reduce bleeding during cesarean section in high-risk bleeding pregnant women, thereby reducing the amount of blood transfusion. In view of this, the purpose of this study was to observe the effect of controlled hypotensive technique on blood loss and neonatal Apgar score in high-risk bleeding pregnant women during cesarean section, and to provide a theoretical basis and data support for the application of this technique in such surgery.

## **MATERIALS AND METHODS**

### ***Clinical data***

A total of 75 pregnant women with high-risk hemorrhage at caesarean section from January 2016 to June 2017 were enrolled in Qilu Hospital of Shandong University. Inclusion criteria: age 18-45 years old pregnant women; 28-40 weeks of gestation; planned cesarean section termination of pregnancy; dangerous placenta previa or placenta previa with placenta accreta; expected intraoperative blood loss >1000mL. Exclusion criteria: age <18 years or >45 years of pregnant women; combined systemic disease; urgent or immediate cesarean section; expected intraoperative blood loss <1000mL; rapid bleeding need to use vasopressors to maintain blood pressure; the patient refused. All participants provided written informed consent and the study was approved by Qilu Hospital of Shandong University.

### ***Methods***

The patients included in the study underwent 24-hour ambulatory blood pressure monitoring prior to surgery to define the normal blood pressure range and basal blood pressure. They were then randomly divided into three groups (25 cases in each group): Controlled hypotension group 1 (H1 group), Controlled hypotension 2 (H2 group) and normal blood pressure group (N group). Two groups of patients with controlled hypotension were admitted to the room with conventional masks for oxygen and electrocardiogram monitoring. The left side was tilted by 30 degrees and concurrent arterial was punctured continuously to monitor invasive arterial pressure. In the H1 group, after removing the fetus and disconnecting the umbilicus, the micro pump was pumped into phentolamine 2-6 $\mu$ g/kg/min. Within 5 minutes, the mean arterial pressure (MAP) was reduced to 80% of the basal blood pressure, and the dosage was adjusted according to the blood pressure. Similarly, in the H2 group, after removing the fetus and disconnecting the umbilicus, the micropump was pumped into phentolamine 2-6  $\mu$ g/kg/min. Within 5 minutes, the MAP was reduced to 70% of the basal blood pressure, and the dosage was adjusted according to the blood pressure. Cases in the N group was pumped into saline after removing the fetus and disconnecting the umbilicus as control, and the blood pressure was maintained in the normal range.

### ***General anesthesia induction and maintenance program***

Propofol plasma target 3 $\mu$ g/ml with remifentanyl plasma target 3ng/ml and rocuronium 0.6mg/kg. After removing the fetus and disconnecting the umbilicus, midazolam 2 mg and fentanyl 0.2 mg were administered intravenously immediately. After entering the room, the left side of the operating table is tilted by 30 degrees immediately to prevent supine hypotension. If hypotension occurs in the supine position, the uterus is pushed to the left side. If it still cannot be relieved, phenylephrine intravenous injection is performed to ensure the level of MAP at 70% or 80% of the basal blood pressure in H the group. The N group had normal blood pressure.

### ***Observation indicators***

The preoperative general clinical data, intraoperative and in-hospital days, neonatal outcomes and postoperative complications were statistically analyzed and compared among the groups. Apgar score (Shirmohammadi *et al.*, 2009) evaluation criteria are normal neonates with full score of 10 points, newborns with scores of 7 points or less are considered mild asphyxia, and scores below 4 points considered severe asphyxia.

## **STATISTICAL ANALYSIS**

Using SPSS 21.0 statistical software, the measurement data were expressed as mean  $\pm$  standard deviation. t-test was used to compare the measurement data between the two groups. The measurement data of the three groups were compared using one-way ANOVA followed with LSD test, and the comparison of count data was performed using the chi-square test.  $P < 0.05$  was considered statistically significant.

## **RESULTS**

### ***Comparison of preoperative general conditions in each group of patients***

The ages of the three groups were 31.3 $\pm$ 4.2, 32.8 $\pm$ 3.9 and 34.1 $\pm$ 3.4 year, respectively. The body weights were 79.2 $\pm$ 15.8, 73.8 $\pm$ 14.3 and 78.1 $\pm$ 13.2 kg, respectively. The basal blood pressure and weeks of gestation were 91.7 $\pm$ 10.5 mmHg and 34.5 $\pm$ 2.7 in N group, 86.7 $\pm$ 7.8 mmHg and 33.1 $\pm$ 3.0 in H1 Group and 88.1 $\pm$ 8.1 mmHg and 35.2 $\pm$ 1.9 in H2 Group. There was no significant difference in age, weight, gestational age basal blood pressure, and weeks of gestation among the three groups ( $P > 0.05$ , table 1).

### ***The indicators of newborns in each group***

There was no significant difference in Apgar scores of 1min and 5min among newborn infants and in the level of pH, PaCO<sub>2</sub>, and PaO<sub>2</sub> in the umbilical vein blood ( $P > 0.05$ , table 2).

### ***Comparison of intraoperative conditions and hospitalization days in each group***

Compared with the N group, the intraoperative plasma

**Table 1:** Preoperative general conditions in each group ( $\bar{x} \pm s$ )

Groups	N Group	H1 Group	H2 Group
n	25	25	25
Age (Y)	31.3±4.2	32.8±3.9	34.1±3.4
Body Weight (kg)	79.2±15.8	73.8±14.3	78.1±13.2
Basal blood pressure (MAP, mmHg)	91.7±10.5	86.7±7.8	88.1±8.1
Weeks of gestation (W)	34.5±2.7	33.1±3.0	35.2±1.9

Note: There was no statistical significance in age, weight, basal blood pressure, and weeks of gestational among all groups ( $P>0.05$ ).

**Table 2:** Comparison of Apgar scores and umbilical vein blood gas analysis between each group ( $\bar{x} \pm s$ )

Groups (kPa)	n	Apgar Score		pH	PaCO <sub>2</sub>	PaO <sub>2</sub>
		1 min	5 min			
N Group	25	8.21±1.28	9.62±0.12	7.34±0.15	30.21±6.28	55.31±2.27
H1 Group	25	8.57±0.92	9.71±0.20	7.38±0.08	29.65±6.89	53.53±3.18
H2 Group	25	8.93±0.81	9.79±0.11	7.30±0.12	28.08±7.20	52.76±5.05

Note: Apgar scores of 1min and 5min in newborn infants of all groups were not statistically significant ( $P>0.05$ ). There was no significant difference in the level of pH, PaCO<sub>2</sub>, and PaO<sub>2</sub> in the umbilical vein blood ( $P>0.05$ ).

**Table 3:** Comparison of intraoperative blood loss, infusion volume, infused red blood cells, plasma and urine volume, and length of hospital stay in each group ( $\bar{x} \pm s$ )

Groups	N Group	H1 Group	H2 Group
n	25	25	25
Hemorrhage volume (ml)	2246.5±708.4	1855.8±710.6	1628.4±628.5 <sup>a</sup>
Infusion volume (ml)	3050.4±695.2	2191.7±529.5	1954.4±558.6 <sup>a</sup>
Red blood cells (U)	8.8±3.7	7.2±2.9	5.4±2.7 <sup>ab</sup>
plasma (ml)	600.6±339.6	408.4±289.2 <sup>a</sup>	306.2±268.8 <sup>a</sup>
urine volume (ml)	517.3±339.2	476.6±402.8	505.2±345.6
Operation time (min)	101.5±12.8	90.8±10.9 <sup>a</sup>	82.5±11.2 <sup>a</sup>
Hospital stay time (d)	5.8±1.6	5.6±1.8	5.2±1.2

Note: Compared with N group, <sup>a</sup> $P<0.05$ ; Compared with H1 group, <sup>b</sup> $P<0.05$ .

**Table 4:** Comparison of postoperative complications in each group

Groups	n	Nausea vomiting	Puerperal infection	Venous thrombosis of the lower limb	Puerperal hemorrhage
N Group	25	3	1	0	1
H1 Group	25	2	0	0	1
H2 Group	25	3	0	1	0

Note: There was no significant difference in postoperative complications ( $P>0.05$ )

infusion volume in H1 group was significantly reduced and the operation time was significantly shortened ( $P<0.05$ ). However, there was no significant difference in intraoperative blood loss, infusion volume, and red cell transfusion volume between two groups ( $P>0.05$ ). Compared with the N group, intraoperative blood loss, infusion volume, red blood cell and plasma transfusion volume in H2 group were significantly reduced, and the operation time was significantly shortened ( $P<0.05$ ). Compared with H1 group, the red blood cell transfusion volume was significantly decreased in the H2 group ( $P<0.05$ ), but there was no significant difference in intraoperative blood loss, infusion volume and plasma

infusion volume between the two H groups ( $P>0.05$ ). There was no significant difference in urine volume and hospitalization days among the three groups ( $P>0.05$ , table 3)

#### **Comparison of postoperative complications in each group**

The postoperative nausea, vomiting and bleeding during puerperium in each group are shown in table 4. The incidence of postoperative complications was similar in the three groups. There was no statistical difference among the three groups. One case of venous thromboembolism in the lower extremities was found in the H2 group.

## DISCUSSION

Arterial balloon occlusion, preoperative autologous blood preparation and intraoperative autologous blood transfusion can reduce intraoperative hemorrhage during high-risk bleeding in cesarean delivery (Ehtisham and Akhtar Hashmi, 2014). But either require special equipment, or need multidisciplinary collaboration, or because of potential risks and ethical issues, these technologies are not widely used. Compared with the above technologies, the controlled hypotensive technology is relatively simple and safe, especially in the basic hospital, as long as there are related antihypertensive drugs can be implemented, so it has great application value. At present, there is still a lack of application of controlled antihypertensive technology in high-risk bleeding cesarean section at home and abroad.

The study found that the nature of neonatal asphyxia is organ dysfunction and organ damage caused by hypotensive acidosis. Fatal hypotensive ischemia can lead to CO<sub>2</sub> accumulation and PaCO<sub>2</sub> increased, and anaerobic glycolysis causes large accumulation of metabolites such as lactic acid in order that a mixed acidosis state appeared in the body (Stuart *et al.*, 2011). Umbilical arterial blood gas analysis can directly reflect the neonatal acid-base balance and can be used as a diagnostic method for neonatal asphyxia. Our study found that there was no significant difference in Apgar scores of newborns in three groups.

Phentolamine is a fast-acting alpha-blocker that antagonizes the effects of catecholamines and acts directly on vascular smooth muscle to induce vasodilation and reduce vascular resistance (Chattergoon *et al.*, 2005; Cannavo *et al.*, 2017). At the same time, phentolamine has an indirect  $\beta$  effect that can increase myocardial contractility and cardiac output (Chen *et al.*, 1998; Murphy *et al.*, 2003). In this study, we reduced MAP to 70% or 80% of basal blood pressure by continuous pumping of phentolamine and found that the plasma transfusion was significantly lower when the MAP was reduced to 80% compared to the normotensive group. The reduction of operation time was significantly shortened, but there was no significant difference in blood loss, infusion volume and red cell transfusion volume between the two controlled hypotension groups. When the MAP was reduced to 70%, the amount of intraoperative blood loss, infusion volume, red blood cell and plasma transfusion volume were significantly reduced, and the operation time was significantly shortened. These results suggest that the use of controlled hypotension (down to 70% of basal blood pressure within 5 minutes) can significantly reduce intraoperative blood transfusions, but it was found that a case of venous thrombosis in the lower extremity in this group. Whether or not it is related to controlled hypotension requires a large sample study for analysis.

## CONCLUSION

This study serves as a pioneer research and our findings of controlled hypotension can reduce the incidence of hemorrhage and postpartum hemorrhage provide novel insights and possible novel therapeutic strategies toward obstetric hemorrhage.

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