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Case Report

# Hypervolemic Hemodilution as a Management During Predicted Massive Bleeding Sectio Caesarea in Placenta Accreta Patient

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**ABSTRACT**

**Background:** Placenta accreta represents one of the most morbidity conditions in modern obstetrics, with high hemorrhage rates, hysterectomy, and intensive care unit admission. Alternative management during intraoperative bleeding is haemodilution. There are two techniques in hemodilution, including autonomic normovolemic hemodilution and hypervolemic hemodilution.

**Case:** A gravida patient, physical status ASA II with a suspected placenta accreta was planned for a cesarean section. Hypervolemic hemodilution was conducted to anticipate bleeding. Hemodilution was performed with a total fluid of 2000 ml. Total bleeding during surgery is 3500 ml. Close monitoring of hemoglobin (Hb) and hematocrit (Hct) was conducted. The initial Hb and Hct were 9.9 mg/dl and 29.8%. Hb and Hct post-haemodilution 5.7 mg/dl, and 17.1%. Postoperatively, Hb and Hct become 5.4 mg/dl and 16.6%. The patient has been given 450 ml packed red cells (PRC) blood transfusion. The patient was observed in the intensive care unit for 24 hours postoperatively and was subsequently transferred to the ward. The total bleeding was 3500 ml, and there was a reduction of Hb from 5.7 to 5.4 and Hct from 17.7% to 16.6%.

**Conclusion:** In this case, hemodilution was proven effective based on the post-hemodilution and post-hemorrhage Hb and Hct. Hemodilution may be alternative management during intraoperative hemorrhage. However, the anticipation and effect that might arise from hemodilution should be considered.

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## INTRODUCTION

Placenta accreta represents one of the most morbidity conditions in modern obstetrics, with high hemorrhage rates, hysterectomy and intensive care unit admission. It's because of an abnormality of invasion in the uterine wall by placental tissue. Symptoms related to placenta accreta may include vaginal bleeding and cramping. Accurate prenatal diagnosis of placenta accreta is essential to minimize complications and optimize management.[1]

Clinically, placenta accreta is a challenge during pregnancy. Incomplete separation of the placenta and the uterus with massive bleeding can cause disseminated intravascular coagulation (DIC), hysterectomy, urinary tract issues such as the ureter, bladder, or neurovascular. This massive bleeding may cause several problems, including transfusion reaction, electrolyte imbalance, and kidney injury. Hemostasis often cannot be achieved promptly in cases of massive hemorrhage during cesarean section, accompanied by DIC. In such obstetric facts with DIC, particularly in the presence of hypothermia, acidosis, and vasopressor requirement, damage control surgery (DCS) and resuscitation, which represent the performing of the therapeutic concept of life-saving intervention for severe trauma because ordinary hemostatic procedures such as sutures, ligation, and coagulation, etc., are not effective and bleeding persists.[1,2]

There are several alternative managements during intraoperative bleeding: autologous transfusion, blood salvage & reinfusion, hemodilution, and donor-directed transfusion.[3] In most cases, the utilization of hemodilution as an option to reduce blood loss and prevent blood transfusion without sacrificing tissue oxygenation. Hemodilution exposures cause anemia, which initiates compensation by maintaining blood flow and tissue oxygenation. The basic physiology of hemodilution includes an increased cardiac output and an increased number of perfused capillaries. This adaptation mediates by blood viscosity reduction, also known as

hematocrit.[4] There are two techniques of hemodilution, autonomic normovolemic hemodilution (ANH) and hypervolemic hemodilution.

Hypervolemic hemodilution (HHD) is easier and less expensive than ANH. In HHD, a colloid fluid volume prescribes to initiate HHD. Several studies have demonstrated that HHD does not cause an excessive blood pressure increase, and no signs of excessive increase in the intravascular fluid.[5] The HHD technique is not entirelysafe, and the effects of hypervolemia and hemodilution should be the consideration. Hemodilution carries the risk of anemia and hypoxemia, whereas hypervolemia carries the risk of pulmonary edema, cerebral edema, hyponatremia, and congestive heart failure. Therefore, the relative contraindications of this technique include patients with coronary vascular disease and cerebral vascular disease, myocardial dysfunction, hypertension, and coagulopathy. When using this technique, close monitoring of fluid balance, diuresis, electrocardiogram (ECG), and oxygen saturation, up to invasive blood pressure measurement, is also required.[5]

The difficulty accessing a sufficient blood supply makes this hypervolemic hemodilution a choice. However, the available information regarding this technique is still limited. Therefore, we present a haemorrhage caseduring placenta accrete surgery using the hypervolemic hemodilution technique.

## CASE

A 32-years old woman with a bodyweight of 76 kg and height of 158 cm with a diagnosis of G2P1001 Ab000 gravida 34-36 weeks presented with antepartum bleeding due to total placenta previa, suspected of placenta accreta, and history of C-section. The suspicion of placenta accreta was due to the PAI score of 2.5 obtained from the myometrium thickness of 1, anterior placenta 1, and bridging vein 0.5. The physical examination showed no other abnormalities. The patient's physical status was American Society of Anesthesiologist (ASA) II Gravida and anemia 9.9 mg/dl. The basic laboratory tests include complete blood count, hemostasis tests, albumin, liver function, kidney function, and electrolytes in the preoperative preparation. Subsequently, the patient was placed with 2 intravenous (IV) lines of 18G, and a blood sample was extracted for a crossmatch. The blood supply was 4 bags of PRC, 700 ml of fresh frozen plasma (FFP), and 700 ml of thrombocyte concentrate (TC). In the operative room, an arterial line was placed to monitor the blood pressure intraoperatively regularly. Afterward, a colloid and crystalloid fluid were given to hemodiluted the patient's blood, with a 15-20% hematocrit target. The induction was performed using the regimen of heavy bupivacaine 0.5% 20 mg with an adjuvant of 0.1 mg morphine. After the spinal anesthesia, the patient was placed in a supine position without head down. After the fluid administration for hemodilution, a blood sample was extracted from the arterial line to check the complete blood count and blood gas analysis (BGA). The fluids for hemodilution were 500 ml of gelofusine and 1500 ml of crystalloid. Following the hemodilution, the complete blood count revealed the Hb value of 5.7 mg/dl and the hematocrit value of 17.1%. The following procedure maintained the patient's hemodynamic by maintaining the mean arterial pressure (MAP) value of >65 mmHg, close monitoring of blood loss, and replacing lost fluids using crystalloids and colloids. The total surgery time was 2.5 hours, with a total bleeding of 3500 ml and an estimated blood volume of 4940 ml. The intraoperative fluid management was performed using crystalloid NaCl 0.9%, Ringer Lactate, and gelofusine colloid. The crystalloids and colloids were administered until the bleeding was adequately controlled. The total crystalloid administered was 3800 ml, and the colloid was 1500 ml, with urine production in 2.5 hours of 1000 ml. The blood transfusion was started once the bleeding had been controlled. Furosemide with a dosage of 20 mg was given to prevent the potential fluid overload. After the surgery, the patient was transferred to the ICU for clinical evaluation, monitoring, and laboratory examinations.

The intraoperative monitoring graph showed no significant hemodynamic decrease. The patient's MAP was still maintained with an average of 65 mmHg. In the 30$^{th}$ minute, there was much bleeding causing tachycardia (more than 120 times/min); however, the issue was quickly resolved. The same problem occurred in the 60$^{th}$ minute, and the bleeding was still not adequately controlled. The graph also showed the hemodynamic status following the spinal anesthesia induction, which showed no decrease in the hemodynamic status following full-dose bupivacaine.

**Table 1.** Patient's characteristics, hemodilution, initial Hb, and final Hb values

| | Case presentation |
|---|---|
| Age and comorbidities | 32 years old, 76 kg, ASA II |
| Initial Hb and Hct | Hb 9.9 mg/dl Hct 29.8% |
| Hemodilution Fluid | Gelofusine 500 ml, RL 1500 ml |
| HB and Hct Post-hemodilution | Hb 5.7 mg/dl; Hct 17.1% |
| BGA Post-hemodilution | pH 7.34<br>$PaCO_2$ 29.5<br>$PaO_2$ 163.1<br>HCO3 16.1<br>BE -9.8<br>$SpO_2$ 96% |
| Total bleeding | 3500 ml |
| Hb and Hct Post-hemorrhage | Hb 5.4 mg.dl; Hct 16.6% |
| Blood transfusion | 450 ml PRC |
| Hb and Hct Post-hemorrhage | Hb 9.4 mg/dl; Hct 28.2% |
| Post-operative laboratory results in the ICU (post-operative day 0) | Na 137; K 3,96; Cl 109<br>Hb 9.4; WBC 16,740; Hct 28.3; Platelet 250 000<br>PT 10.5; INR 1.01; APTT 30.4<br>Lactic acid 1.5<br>Albumin 2.51 |
| Complications | Lung edema (-), hyponatremia (-), coagulopathy(-), hypoalbuminemia (-) |

BGA: blood gas analysis; Hb: hemoglobin; Hct: hematocrit; ICU: intensive care unit; PT: prothrombin time; APTT: activated partial thromboplastin time; INR: International normalized ratio; PRC: packed red cells

Regular hemoglobin and hematocrit examination were performed. The patient's initial Hb and Hct were 9.9 mg/dl and 29.8%, respectively, and hemodilution with 1500 ml of crystalloid and 500 ml of colloid was conducted. The result of hemodilution showed a decrease in Hb to 5.7 mg/dl and hematocrit to 17.1%. The total bleeding was calculated at the end of the surgery and when there was no more bleeding. Total bleeding of 3500 ml was obtained. The complete blood count

showed a 5.4 mg/dl Hb value and Hct of 16.6%. The patient was given 450 ml of PRC transfusion with premedication of furosemide 20 mg. After the surgery, the patient was transferred to the ICU for clinical and laboratory observations. The laboratory results showed Hb value of 9.4 mg/dl and Hct value of 28.2%. The platelet and coagulation tests were within normal limits, with no increase of lactic acid.

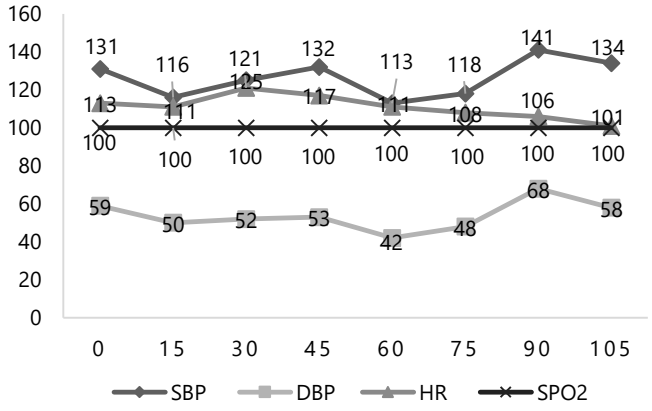


**Figure 1.** Intraoperative monitoring

## DISCUSSION

Several methods have been used as an alternative to a homologous blood transfusion during surgery. Hemodilution is a blood protection method widely used during the perioperative period. It can significantly reduce the amount of intraoperative blood loss, help control the demand for allogeneic blood, reduce adverse reactions and disease transmission caused by blood transfusion, save blood resources, and reduce the medical burden of patients. Hemodilution can also improve the supply to the tissue microcirculation, with a definite action of organ protection.[6,7] The hemodilution methods include acute isovolumetric hemodilution and acute hypervolemic hemodilution, the latter of which is less difficult to perform, requires less equipment and fewer human resources, and it can effectively reduce the risk of blood contamination and damage to the blood components. [6,7]

Acute hypervolemic hemodilution (AHH) refers to the rapid infusion of a certain dose of colloidal fluid or crystal fluid over a period which ultimately leads to rapid dilution of blood volume and decrease of hematocrit level, and it increases the circulating blood volume by approximately 20%-25% and reduces the effective blood component concentration.[8] By performing acute hypervolemic hemodilution treatment, one is assured that under the premise of the same amount of bleeding, the loss of adequate blood components can be significantly reduced, the patients will have a higher blood loss tolerance, and it helps maintain a balanced state of cerebral oxygen supply and demand At present, acute hypervolemic hemodilution is widely used in thoracic operations, spinal operations, aneurysm operations, gastrointestinal operations, liver operations, meningioma operations, urinary system operations, and the results have been proved to be satisfactory. [6]

Some studies underwent acute hypervolemic hemodilution using Ringer lactated solution (crystals), and 6% hydroxyethyl starch (colloid) were mixed at a ratio of 1:1 and infused at a dose of 20 ml/kg, with speed controlled at 50 ml/min. They observed their patient, including blood gas analysis, rates, and volumes of the intraoperative blood transfusion, adverse reaction including water intoxication, and pulmonary edema. This study concludes that acute hypervolemic hemodilution can maintain a stable hemodynamic state, reduce blood transfusion.[6]

The use of AHH in the present study gave the advantages of improving microcirculation and preventing capillary leakage. However, AHH alone inevitably could lead to increased cardiac preload with increased myocardial oxygen consumption and pulmonary capillary leakage, so the protocol of the present study used the combination of AHH with Controlled hypotension that could efficiently expand the plasma volume and possessed the character of hematology that could improve the microcirculation and prevent the pulmonary capillary leakage. Subsequent reduction of hematocrit to 25% could offer the maximum oxygen transport, decreasing blood viscosity that improved tissue blood perfusion and subsequently improved tissue oxygenation.[8]

In our case, the hemodilution was proven to be effective based on the post-hemodilution and post-hemorrhage, and hematocrit values. The total bleeding was 3500 ml with a reduction in HB from 5.7 to 5.4 and hematocrit from 17.7% to 16.6%. As a result of this hemodilution, the fluid loss was not only from the red blood cells but also from the hemodilution, in accordance with the literature.

Several factors determine the efficacy of hemodilution, including red blood cell mass. Patients with abundant red blood cells can donate more blood. The red blood mass is based on the hematocrit and blood volume. There will be less red blood loss when a lower hematocrit level is achieved after hemodilution. However, this hemodilution causes a more profound hemodynamic consequence. If more blood is removed, the operative hematocrit will be lower, and consequently, fewer red blood cells are lost during the surgery. Intraoperative hemorrhage also plays some factors to determine the efficacy of hemodilution. Furthermore, the last factor is Intraoperative management. When the normovolemic condition is ineffective and is maintained after autologous hemorrhage, the procedure does not reduce red blood cells. In the absence of hemodilution, operative blood loss will occur at a higher preoperative hematocrit level. [6–8]

A hypervolemic hemodilution without the combination of vasodilator can cause pulmonary congestion and edema due to fluid overload.[8] In this technique, an anesthetic technique with a subarachnoid block is performed, in which the effect includes vasodilatation. Therefore, no signs of pulmonary congestion would be found. Moreover, we can see from the postoperative laboratories that there is no sign of coagulopathy and tissue hypoxia, where is the lactic acid level is only 1.5.

## CONCLUSION

In the patient's management, the patient experienced two sources of blood loss, related to the hemodilution and operative bleeding, causing the crystalloid or colloid volume requirements to be higher during the intraoperative period. The changes in the intravascular volume need to be closely monitored during the procedure to ensure a maintained intravascular volume throughout the surgery. More red blood cells will be lost when a hemoconcentration occurs in the patient. Compared to the hemodilution condition, the concern of hypervolemic hemodilution is postoperative edema due to crystalloid and colloid fluids. This issue can be anticipated with vasodilators, with a hematocrit target in a hemodiluted condition of 25%. Some studies use magnesium sulfate or nitroglycerine to achieve vasodilatasion effect, but in this case,

we use regional anesthesia sub arachnoid block to get this mechanism. In lower hematocrit levels, more close monitoring will be done required. Serial hematocrit and blood gas analysis examinations may help determine the estimated blood loss, evaluate fluid replacement, and provide information regarding sufficient oxygen deliveries. Tachycardia and ECG changes suggesting myocardial ischemia are signs of inadequate oxygen delivery due to anemia. The decreased blood viscosity as a result of hemodilution often lowers the blood pressure. Therefore, severe hemodilution cannot be conducted with a deliberate hypotensive technique because it can reduce oxygen deliveries to the tissues.


## ACKNOWLEDGMENT

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## CONFLICT OF INTEREST

None

## REFERENCES


1. Carusi D. Placenta accreta: Epidemiology and risk factors In: Placenta Accreta Syndrome CRC Press; 2017:1-12
2. Takeda S, Takeda J, Makino S. Cesarean section for placenta previa and placenta previa accreta spectrum. *The Surgery Journal*. 2020;6(S 02): S110-S121
3. Morgan GE, Mikhail MS. *Morgan & Mikhail's Clinical Anesthesiology*. McGraw-Hill Education; 2018
4. Rajuddin R, Roziana R, Munawar M, Iqbal M. Management Placenta Percreta Succesfully With Total Abdominal Hysterectomy A Case Review. AVERROUS: *Jurnal Kedokteran dan Kesehatan Malikussaleh.* 2019;5(1):52-62
5. Martinez JCD, Martinez AMD, Villarejo GP. Abstract PR017: Limits of Hypervolemic Hemodilution in Jehovah'S Witnesses Patients. *Anesthesia & Analgesia*. 2016;123(3S):29
6. Wu J, Zhang Z. The effects of acute hypervolemic hemodilution and conventional infusion in laparoscopic radical prostatectomy patients. *American Journal of Translational Research*.2021;13(7):7866
7. Guo J, Yuan X, Zhou X, Jin X. Pharmacokinetics and pharmacodynamics of cisatracurium in patients undergoing surgery with two hemodilution methods. *Journal of clinical anesthesia*. 2017;38:75-80
8. Elnaghy KM, Nasr I-E, Kamal EM. Acute hypervolemic hemodilution combined with controlled hypotension to minimize blood loss during operations of spine fusion: remifentanil versus magnesium sulfate. *Ain-Shams Journal of Anesthesiology*. 2021;13(1):1-10