

Original Article

Results of surgical intervention in treating post-cesarean intractable postpartum hemorrhage

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Abstract: This study aimed to investigate the clinical effects of different surgical interventions in treating post-cesarean intractable postpartum hemorrhage (pC-IPH). The clinical data of 75 pC-IPH cases were retrospectively analyzed, and the hemostatic measures were divided into the uterine packing group (group A, 33 cases), improved uterine strapping group (group B, 25 cases), and uterine artery embolization group (group C, 17 cases). The blood loss, operative time, hemostasis success rate, and hysterectomy rate were compared among the groups. The blood loss and operative time of group C were less than groups A and B (258/723, 556, 48/67, 71, $P < 0.05$); the hemostasis success rate and hysterectomy rate of groups C, A, and B were 88.2/78.8, 72.0, $P > 0.05$, and 11.8/12.1, 16.0, $P > 0.05$, respectively. The hemostasis success rate in patients with placental factors was higher in group C than in groups A and B (100/33.3, 0.0, $P < 0.05$). Surgical intervention had good hemostatic effect for IPH, and arterial embolization had the advantages of less bleeding, shorter operative time, and better hemostatic effect; high risk of failed hemostasis was due to placental factors and coagulation disorders.

Keywords: Cesarean, intractable postpartum hemorrhage, uterine packing, uterine strapping, uterine artery embolization, effect

Introduction

With the development of perinatal medicine, as well as continuous improvements in anesthesia and surgical technologies, cesarean section had increasingly become the primary means of managing a difficult delivery, and terminating certain pathological pregnancies [1]. In addition, with changed attitudes toward childbirth, social factors caused an expansion of cesarean indications [2]. Clinical studies had shown that cesarean section was one of the high-risk factors leading to postpartum hemorrhage, with a reported occurrence rate of 19.5% [3]. Moreover, cesareans for pregnancy complications are more prone to severe postpartum hemorrhage because of various high-risk factors. Intractable postpartum hemorrhage (IPH) [4] refers to hemorrhage that cannot be stopped 1 hour after delivery through uterine massage and uterotonic agents, with blood loss more than 1500 ml or the development of a coagulation disorder or multi-organ failure. It was

reported [5] that the IPH rate was about 4.5%, that it was more commonly seen in cesarean delivery, and that it was the leading cause of maternal mortality. IPH could be dangerous, and the treatment difficult, thus necessitating surgical intervention. The surgical measures included internal iliac artery ligation, uterine packing, uterine strapping, uterine artery embolization, and hysterectomy, among others. However, no method had an absolute advantage in treating IPH [6]. The technical difficulties of internal iliac artery ligation were great, and the technique was difficult to master [7]; hysterectomy could effectively control bleeding, but with permanent loss of reproductive function, with the potential for severe adverse effects on physical and mental health [8]. Therefore, the choice of a quick, easy, safe, and effective hemostatic method was a common concern among most obstetricians. This paper analyzed the clinical data of 75 post-cesarean intractable postpartum hemorrhage (pC-IPH) cases performed in our hospital, to assess the inter-

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ventional processes and their effects, and investigate the rationale and effectiveness of various treatment measures, thus improving the management and prognosis.

Materials and methods

General information

The clinical data of 75 pC-IPH cases treated from May 2006 to May 2014 in our hospital were collected, and patients were divided into different groups according to the hemostatic method: uterine packing (group A, 33 cases), improved uterine strapping (group B, 25 cases), and uterine artery embolization (group C, 17 cases). The patients were 21-42 (29.8±4.6) years old and the gestational age was 35-42 (37.7±2.6) weeks. Sixty-one were primiparas, and 14 were multiparas. The causes of postpartum hemorrhage included 27 cases of uterine inertia, 33 with placental factors, 3 with reproductive tract injury, and 8 with a coagulation disorder. The comparison of maternal age, gravidity, and parity, as well as gestational age and other general information, showed no statistically significant difference ($P > 0.05$). This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Capital Medical University. Written informed consent was obtained from all participants.

Diagnostic criteria

1) Ineffective conservative treatments, such as uterine massage, uterotonic agents, saline wet packs, and others; 2) 1500 ml blood loss within 1 hour after delivery; 3) bleeding leading to a coagulation disorder or multi-organ failure. Diagnosis requires meeting criteria 1) and 2), or 1) and 3) [4]. The amount of blood loss is determined by a combination of visual, volumetric, area, and weighing methods, and hemoglobin level measurement [9].

Hemostatic intervention

Once IPH occurs, physicians should institute different measures, such as uterine packing, improved uterine strapping, and uterine artery embolization, based on individual clinical experience, the primary cause of bleeding, and associated disease conditions. The general progression is from simple to complex, and

from noninvasive to invasive methods, with preservation of fertility, if possible; if the above interventions are ineffective or life is threatened, timely hysterectomy is performed.

Group A: During cesarean section, several gauze packs are stacked from top to bottom under direct vision; patients with placenta previa are then packed from bottom to top, making sure the entire uterine cavity is packed, and the uterus is sutured and knotted in middle; the gauze is removed after 24 hours.

Group B: With the uterus supported outside the abdominal cavity, the likelihood of successful hemostasis is first estimated. If bleeding can be mostly terminated with pressure, Vicryl 1-0 suture is placed first at the lower edge, 2-3 cm to the right lateral margin of the uterus, and knotted; with the suture retained, the needle is withdrawn 2-3 cm above the incision, then directed perpendicularly towards the uterine bottom, suturing from the myometrium of the right uterine wall to the posterior uterine wall (with suture spacing of 2.5 cm), equal to the needle position in the anterior wall; at this level, the avascular zone of the right broad ligament is selected to direct the needle from back to front, penetrating the broad ligament and anterior wall; and the suture is retained and knotted. The left uterine wall is then ligated and knotted with the same method.

Group C: The Seldinger method is used for puncture, after visualization of the pelvic uterine arteries by angiography; after the bleeding artery is identified and catheterization is performed, gelatin sponge particles are implanted for the embolization; arterial embolization towards the contralateral side can be performed after digital subtraction angiography confirms the completion of the initial embolization.

Observation indicators

The preoperative, intraoperative, and total blood loss; operative time; hemostasis success rate; and hysterectomy rate of each group were evaluated. Criteria of hemostatic effectiveness were as follows: firm uterine contractions; vaginal bleeding ≤ 50 mL/h, gradually reducing or stopping; stable vital signs; normal urine volume. Criteria of ineffectiveness were as follows: poor uterine contractions; vaginal bleed-

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Table 1. Causative factors of Intractable Postpartum Hemorrhage (n = 75)

Bleeding	Uterine inertia				Placenta factor			Genital injury	Coagulation disorder	
Factor	Ts	Ms	AoL	SU	PP	PA	PAc	IUR	AFE	HELLP-Syndrome
Number	5	3	6	13	21	9	7	3	4	4
Total	27/75 (36.0%)				37/75 (49.3%)			3/75 (4.0%)	8/75 (10.7%)	

Note: Ts-twins; Ms-macrosomia; AoL-arrest of labor; SU-scarred uterus; PP-placenta previa; PA-placenta abruption; PAc-placenta accrete; IUR-incomplete uterine rupture; AFE-Amniotic fluid embolism; HELLP-Syndrome-Hemolysis, Elevated liver enzymes, Low platelet count.

Table 2. Comparison of hemostatic success rate of different bleeding cause among groups (n, %)

Group	Uterine atony	Placenta previa	Placenta abrup	Placenta accrete	Uterine rupt	Dyscoagulat	Total
Group A	6/7 (85.7)	11/12 (91.7)	5/6 (83.3)	1/3 ^a (33.3)	1/1 (100.0)	2/4 (50.0)	26/33 (78.8)
Group B	11/13 (84.6)	1/3 (33.3)	2/3 (66.6)	0/2 (0.0)	2/2 (100.0)	1/2 (50.0)	18/25 (72.0)
Group C	7/7 (100.0)	5/6 (83.3)	-	2/2 (100.0) ^b	-	1/2 (50.0)	15/17 (88.2)
Total	24/27 (88.9)	17/21 (81.0)	7/9 (77.8)	3/7 (42.9)	3/3 (100.0)	4/8 (50.0)	59/75 (78.7)

Note: ^a-1 case died; ^b- $P < 0.05$, significant difference between Group A and Group B.

Table 3. Comparison of operation related data and outcomes among groups ($\bar{x} \pm s$)

Group	N	Pre-OP-EBL (ml)	In-OP-EBL (ml)	Time-OP (min)	Hemostatic success (n, %)	Hysterectomy (n, %)
Group A ^a	33	1821±89	723±104	67±21	26 (78.8)	4 (12.1)
Group B	25	1657±121	556±85	71±18	18 (72.0)	4 (16.0)
Group C	17	2118±95 ^b	258±80 ^b	48±12 ^b	15 (88.2)	2 (11.8)

Note: ^a-1 case died; Pre-OP-EBL-preoperative evaluating bleeding loss; In-OP-EBL-intraoperative evaluating bleeding loss; Time-OP-time of operation; ^b- $P < 0.05$, significant difference between Group A and Group B.

ing > 50 mL/h; intractable uterine inertia or softness; uncontrollable bleeding; deteriorating vital signs; urine volume < 30 mL/h or no urine production.

Statistical analysis

SPSS13.0 software was used for statistical analysis. The measured data were expressed as $\bar{x} \pm s$, and the *t* test was used for the intergroup comparison; the counted data were expressed as a rate, and the χ^2 test was used for the intergroup comparison, with $P < 0.05$ considered statistically significant.

Results

Causative factors and treatments

The causative factors of IPH were uterine inertia, placental factors, coagulation disorders, and reproductive tract injuries; the placental factors accounted for 49.3%, and uterine inertia for 36.0% (scarred uterus accounted for 48.1%), as shown in **Table 1**. Of the 33 group A interventions, 7 had uterine inertia, 21 had pla-

cental factors, 4 had coagulation disorders, and 1 had genital injury. Of the 25 group B interventions, 13 had uterine inertia, 8 had placental factors, 2 had coagulation disorders, and 2 had reproductive tract injuries. Of the 17 group C interventions, 7 had uterine inertia, 8 had placental factors, and 2 had coagulation disorders, as shown in **Table 2**.

Intraoperative conditions and outcome

In group C, the preoperative blood loss in group C was more than that in groups A and B (2118/1821, 1657), while the intraoperative bleeding was less than that in groups A and B (258/723, 556); the operative time was shorter than that in groups A and B (48/67, 71), and the differences were statistically significant ($P < 0.05$). The hemostasis success rate in group C was higher than that of groups A and B (88.2/78.8, 72.0), while the hysterectomy rate was lesser than that in group A and B (11.8/12.1, 16.0); the difference was not statistically significant ($P > 0.05$), as shown in **Table 3**.

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Among the 75 cesarean patients, the total volume of postpartum hemorrhage was 1600-9000 ml. Of 16 cases of failed hemostasis, 5 underwent uterine artery embolization, and bleeding was successfully stopped (2 cases in group A and 3 in group B were not included in the intervention group). Ten underwent hysterectomy (4 in group A, 4 in group B, and 2 in group C were not successful, and were converted to hysterectomy); 1 was a case of pernicious placenta previa, and died of an amniotic fluid embolism after uterine packing.

Success rates

Among the 75 IPH patients, the hemostasis success rates for uterine inertia, placenta previa, placental abruption, placenta accreta, and coagulation disorders were 88.9% (24/27), 81.0% (17/21), 77.8% (7/9), 42.9% (3/7), and 50.0% (4/8), respectively; the success rates for the first three conditions were the highest, with no statistically significant difference ($P > 0.05$); the success rates for the latter two conditions were lower, and the differences were statistically significant, compared with that for the other conditions ($P < 0.05$). Four cases of scarred uterus (1 in group A and 3 in group B), and 1 case of placenta previa underwent successful uterine artery embolization. The patients with placenta accreta in group C exhibited a significantly higher hemostasis success rate than group A and B, and the difference was statistically significant ($P < 0.05$), as shown in **Table 2**.

Discussion

Clinical studies have demonstrated that the incidence of uterine inertia and injuries in cesarean section for any indication were significantly higher than for vaginal delivery, and the amount of intraoperative blood loss was more than one-time than vaginal delivery [10]. In recent years, due to clinical needs or individual preference, the cesarean rate has steadily increased, and the incidence of repeat pregnancies associated with placenta previa and placenta accreta have consistently increased; thus, cesarean section in a scarred uterus might cause severe postpartum hemorrhage. The data on postpartum hemorrhage showed that placental factors accounted for 49.3%, uterine inertia for 36.0%, and half of the patients had a history of cesarean section, roughly comparable to the numbers reported in

the literature [11]. Therefore, the mode of delivery should be carefully chosen to prevent cesarean delivery in the first pregnancy.

IPH is dangerous, and effective measures should be taken to stop bleeding and save lives. Treatment options should be based on experience and specific maternal circumstances, and all measures should be considered when implementing various rescue measures.

The principle of uterine packing hemostasis [12] is based on compression, and can have an immediate effect in uterine inertia following cesarean section; it is especially effective in bleeding due to placenta previa and placental abruption. According to the literature [13], IPH caused by uterine inertia, placenta previa, and placental abruption, exhibited hemostatic success rates in cesarean section of 66.7%, 75.7%, and 72.7% with uterine gauze packing; the differences were not significant ($P > 0.05$). In this study, the hemostasis success rates were 85.7%, 91.2%, and 83.3%, respectively, with the rate being higher for placenta previa. However, the differences were not statistically significant ($P > 0.05$), indicating that this intervention had good hemostatic effects for several conditions causing IPH, as shown in **Table 2**. In this study, the hemostasis success rate of group A was higher than previously reported. This was believed to be related to timely intervention, compression, and orderly packing. Because this represents a foreign body in the uterus, the patient should be closely monitored to prevent infection, and the gauze should be removed when the bleeding is under control.

The uterine strapping technique [14] uses suture to strap the myometrium, thereby compressing and closing the sinusoids on the uterine placental separation surface. Thus, it can achieve better hemostasis in uterine inertia-induced postpartum bleeding. The hemostasis success rate of uterine strapping is reportedly 84.9% [15]; the current study showed a success rate of 84.6%, similar to the literature. However, the effect was decreased with a seriously damaged uterine wall and thinner myometrium, as with placenta previa, placental abruption, and placenta accreta, with a success rate less than 40%.

Uterine packing and uterine compression suturing had fewer equipment demands, and the operation was simple, rapid, and effective. The

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results of one large-scale IPH treatment study [16] showed that the success rates for hemostasis by uterine packing, uterine strapping, and arterial embolization were 77.5%, 84.9%, and 85.7%, respectively, with no significant difference. In this study, the success rates for the above methods were 78.8%, 72.0%, and 88.2%, and the intergroup comparison showed the difference was not statistically significant ($P > 0.05$), as shown in **Table 3**. Therefore, not all hemostatic measures should be performed in order, and the method chosen should be specifically based on the patient's condition, the surgeon's proficiency, and the hospital's surgical capabilities. In this study, 2 cases in group A and 3 cases in group B failed hemostasis, but supplementary uterine artery embolization was successful; this indicated that uterine packing and uterine strapping could rapidly slow or stop bleeding, and would at least gain time for the next intervention.

In uterine artery embolization, angiography is performed to clearly delineate the direction of flow of vessels and the bleeding sites. Gelatin sponge particles are then used for targeted embolization. After embolization, collateral circulation will not affect the blood supply of the uterus and ovaries. The gelatin sponge particles are completely absorbed within 3 months, the embolized vessels are recanalized, and reproductive function is not affected [17]. In this study, the comparison of hemostasis success rates and hysterectomy rates according to different interventions showed no statistically significant difference. However, although group C had a larger amount of preoperative bleeding and more severe pathology, the 17 cases in group C had an average amount of preoperative bleeding of 2118 ml, while the intraoperative bleeding was lesser than that in groups A and B (258/723, 556), and the operative time was shorter than that in groups A and B (48/67, 71); the comparisons showed statistically significant differences ($P < 0.05$), as shown in **Table 3**. In addition, 5 cases in group A and B that failed hemostasis ultimately succeeded with supplemental uterine artery embolization; this approach thus had advantages, such as less intraoperative bleeding, shorter operative time, and more definitive results.

The analysis of bleeding causes and embolization effects found that in group C, 7 patients

with uterine inertia and 2 patients with placenta accreta achieved success with arterial embolization; among the 6 patients with placenta previa, only 1 patient failed because of excessive bleeding and a coagulation disorder. The hemostasis success rate with embolization was significantly higher than with other methods, while the hysterectomy rate was lower. Therefore, besides rapid hemostasis and shorter operative time, arterial embolization had broader indications and more targeted effects. However, in view of the need for special equipment and interventional radiology, timely and general application is limited. When there is an allergy to contrast agents, dangerous bleeding, a severe coagulation disorder, and unstable vital signs, a patient would not be suitable for this interventional treatment [18, 19]. Under these conditions, a combination of techniques should be rapidly implemented, including uterine packing, uterine compression suturing, and pelvic blood vessel ligation, to stop bleeding or slow the rate to the extent possible, correct coagulation dysfunction, and correct vital signs, thereby creating conditions appropriate for interventional treatment and uterine preservation.

One clinical study [20] reported that the incidence of placenta previa and placenta accreta increased with a prior abortion, intrauterine surgery, and cesarean section. This study showed that placental factors accounted for 49.3% of IPH etiologies. When the placenta is implanted in the lower uterine segment, with a thin muscle layer, it can form a central placenta previa; if a placenta accreta simultaneously occurs, it might be difficult to control PH; this was found to be the most important reason for emergent hysterectomy [21]. In the current study of 75 patients, 59 had successful hemostasis. Of 16 failed cases, 4 had a scarred uterus (1 in group A and 3 in group B); 1 case of placenta previa failed the uterine packing method, but succeeded with uterine artery embolization. Ten patients underwent emergent hysterectomy, with placenta previa, placenta accreta, and coagulation disorders as the primary critical factors. Therefore, the overall hemostasis success rate attributed to the above causes was less than 50%. This was felt to be related to the fact that placenta previa, placental abruption, and placenta accreta cause serious damage to the uterine wall, as

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well as the thinner myometrium, and thus there could be no synergism for effective contraction and hemostasis. Although uterine artery embolization had good hemostatic effects in PH from various causes, this study had 2 failed cases, including 1 due to placenta previa and a scarred uterus from cesarean section, and another due to macrosomia and a scarred uterus, also due to prior cesarean. Both of these patients underwent hysterectomy because of ineffective embolization, and secondary coagulation disorders. Therefore, in patients with these risk factors, IPH prevention and rescue should be anticipated, coagulation disorders should be promptly corrected, and, if necessary, hysterectomy should be performed as soon as possible [22].

In addition, placenta previa and placenta accreta are readily complicated by amniotic fluid embolism, postpartum hemorrhage, and coagulation disorders, and severe cases might be life-threatening [23]. In this study, 1 cesarean case with a dangerous placenta previa had IPH; after uterine packing, coagulation disorders rapidly emerged because of an amniotic fluid embolism, multi-organ failure developed, and the patient died. Therefore, when severe IPH occurs, various measures should be actively undertaken, and the uterus can be preserved with the consideration of patient safety. However, when the patient is critical, or if conservative treatments, including uterine packing and uterine suturing fail, and placenta previa, placenta accreta, and amniotic fluid embolism, combined with vigorous bleeding, severe IPH, uncorrectable disseminated intravascular coagulation and multi-organ dysfunction occur, the uterus should be decisively removed to save the patient's life.

Disclosure of conflict of interest

None.

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