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Effectiveness of Prophylactic Bilateral Internal Iliac Artery Balloon Occlusion in Reducing Intraoperative Blood Loss in Placental Abnormalities: A Prospective Non-Randomised Comparative Study

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Abstract: ***Background: Placental abnormalities such as placenta previa and placenta accreta spectrum are important causes of severe obstetric haemorrhage. Control of intraoperative blood loss during lower segment caesarean section remains a major challenge. Prophylactic internal iliac artery balloon occlusion has been suggested as an adjunct to reduce bleeding, though evidence is still evolving. Methods: This prospective non-randomised comparative study included 60 pregnant women with placental abnormalities undergoing elective lower segment caesarean section. Thirty underwent prophylactic bilateral internal iliac artery balloon occlusion and 30 received standard care. Primary outcome was intraoperative blood loss. Statistical analysis was performed using appropriate tests, with p<0.05 considered significant. Results: Mean intraoperative blood loss was significantly lower in the balloon group (820 ± 210 mL) compared to the control group (1280 ± 320 mL; p<0.001). Duration of surgery was shorter (82.5 vs 104.3 minutes; p<0.001), and haemoglobin drop was less (1.6 vs 3.1 g/dL; p<0.001). Postpartum haemorrhage (10.0% vs 36.7%; p=0.018) and ICU admission (13.3% vs 40.0%; p=0.020) were also reduced. Balloon placement was successful in 96.7% of cases, with minimal complications (6.7%). Conclusion: Bilateral internal iliac artery balloon tamponade appears to be an effective adjunct in reducing intraoperative blood loss and improving perioperative outcomes in patients with placental abnormalities undergoing caesarean section.***

Keywords: Placenta previa; Placenta accreta spectrum; Internal iliac artery; Balloon Occlusion; Obstetric haemorrhage; Caesarean section

1. Introduction

Placental abnormalities such as placenta previa and the spectrum of placenta accreta disorders, including accreta, increta, and percreta, are recognised causes of severe obstetric haemorrhage [1]. These conditions are associated with abnormal placental attachment or invasion into the uterine wall, which can lead to life-threatening bleeding during delivery [2]. With the rising rate of caesarean sections, the incidence of these disorders has increased steadily. Women affected often require complex surgical management at the time of lower segment caesarean section (LSCS), and intraoperative blood loss remains a major concern [3].

Conventional management strategies include planned caesarean hysterectomy, uterotonic agents, and various surgical haemostatic techniques [4]. However, these approaches may not always be sufficient to control bleeding and can be associated with significant morbidity. In recent years, interventional radiological techniques have been explored as adjuncts to reduce blood loss. One such method is prophylactic balloon occlusion of the internal iliac arteries [5]. By temporarily reducing pelvic blood flow, this technique aims to limit intraoperative haemorrhage and improve surgical outcomes.

Bilateral internal iliac artery balloon tamponade is typically performed preoperatively under fluoroscopic guidance. Balloons are placed in both internal iliac arteries and inflated at the time of delivery, thereby decreasing uterine perfusion [6]. This approach may reduce the need for massive blood transfusion and lower the risk of complications related to haemorrhage. Despite its growing use, evidence regarding its effectiveness remains variable[7].

Given the clinical importance of managing obstetric haemorrhage and the evolving role of interventional radiology, further evaluation of this technique is warranted. This study aims to assess the effectiveness of bilateral internal iliac artery balloon tamponade in patients with placental abnormalities undergoing LSCS, with specific focus on its role in reducing intraoperative blood loss.

2. Material and Methods

This study was conducted as a prospective interventional comparative study. The study was carried out in the Department of Radiology at DY Patil Medical College, Navi Mumbai, in collaboration with the Department of Obstetrics and Gynaecology, where all operative procedures were performed. Approval was granted by the Institutional Ethics Committee and the study adhered to the principles of the Declaration of Helsinki and ICMR ethical guidelines. This study was conducted over a span of 12 months. The primary outcome was intraoperative blood loss during LSCS in patients with placental abnormalities. Blood loss was assessed intraoperatively using standard methods, including

measurement of suctioned blood volume and estimation from surgical sponges.

The intervention involved preoperative placement of bilateral internal iliac artery balloon catheters under fluoroscopic guidance. Balloons were inflated during the surgical procedure to reduce pelvic blood flow. The comparator group included patients undergoing LSCS without balloon tamponade, managed with standard obstetric care. Participants included pregnant women diagnosed with placental abnormalities such as placenta previa, accreta, increta, or percreta, who were planned for LSCS. These participants were selected as they were at high risk of significant intraoperative blood loss.

Inclusion Criteria

- Pregnant women diagnosed with placenta previa or placenta accreta spectrum
- Patients planned for elective LSCS
- Patients who provided informed consent

Exclusion Criteria

- Patients with contraindications to interventional radiological procedures
- Patients with severe co-morbid conditions precluding surgery
- Patients who did not consent to participate

Participants were divided into two groups. One group underwent bilateral internal iliac artery balloon tamponade prior to LSCS. The second group underwent LSCS without balloon placement. Allocation was done based on clinical decision-making and availability of interventional radiology services. The procedure was discussed with patients, and group allocation was finalised after informed consent and multidisciplinary consultation. The total sample size was 60, with 30 participants in each group[8].

All eligible individuals attending the facility during recruitment who consented were enrolled. This approach yielded a final sample size of 60. A convenience sampling method was used. This approach was appropriate given the specialised nature of the condition and the tertiary care setting and the non-randomised nature of the study [9]. Patients attending the obstetrics department were initially screened by the treating obstetrician. Eligibility was assessed based on clinical and imaging findings. Final enrolment was confirmed by the Principal Investigator after verification of criteria.

Written informed consent was obtained by the Principal Investigator using pre-approved consent forms in the participant's preferred language. Participants were provided with a detailed information sheet explaining the study objectives, procedures, risks, and rights. Participation was voluntary, with no financial incentives. Consent was obtained in the presence of a witness.

Data Sources

- Clinical records: demographic details, obstetric history
- Imaging reports: confirmation of placental abnormalities
- Operative notes: intraoperative blood loss, duration of surgery
- Laboratory reports: haemoglobin levels, transfusion details
- Postoperative records: complications and recovery parameters

Balloon catheters for internal iliac artery occlusion were used under fluoroscopic guidance. Standard surgical instruments and monitoring equipment were used during LSCS. Data recording was done using structured case record forms. All adverse events were monitored by the clinical team. Events were documented promptly and managed as per institutional protocols. Serious events were reported to the Institutional Ethics Committee.

3. Data Collection Procedure:

Patients attending the obstetrics department were screened for eligibility based on clinical examination and imaging findings. Those meeting the inclusion criteria were identified by the treating obstetrician. The Principal Investigator verified eligibility and explained the study details. Written informed consent was obtained before enrolment. Baseline data including demographic and obstetric details were recorded. Imaging findings confirming placental abnormality were documented. Participants were allocated to study groups based on clinical planning.

For participants allocated to the intervention group, balloon catheter placement was carried out in the radiology suite prior to surgery. The procedure was performed by an experienced interventional radiologist under aseptic precautions. After local anaesthesia, vascular access was obtained through the common femoral artery using the Seldinger technique. Under fluoroscopic guidance, catheterisation of both internal iliac arteries was achieved. Appropriately sized balloon catheters were positioned in the anterior division of each internal iliac artery. Correct placement was confirmed using contrast injection. The balloons were left deflated during transfer to the operating theatre. At the time of surgery, immediately after delivery of the foetus and cord clamping, the balloons were inflated to achieve temporary occlusion of pelvic blood flow. Inflation was maintained for the required duration based on intraoperative bleeding and surgical progress, and then gradually deflated before removal.

Lower segment caesarean section (LSCS) was performed in all participants by the obstetrics team following standard institutional protocols. Intraoperative blood loss was assessed using a combination of methods. The volume of blood collected in suction canisters was measured after subtracting any irrigation fluid. Additionally, surgical sponges and mops were weighed before and after use to estimate absorbed blood. Visual estimation by the operating team was also considered where required. These measurements were recorded immediately after completion of the procedure.

The duration of surgery was noted from the time of skin incision to closure. All intraoperative events were documented in the operative notes. The requirement for blood transfusion was recorded, including the number of units of packed red blood cells and other blood products administered during and immediately after the procedure. Decisions regarding transfusion were made by the treating team based on haemodynamic status and haemoglobin levels.

Postoperative monitoring was carried out in the recovery area and subsequently in the ward or intensive care unit as required. Vital parameters, urine output, and clinical signs of ongoing bleeding were closely observed. Postoperative haemoglobin levels were measured as per protocol. Any complications, including haemorrhage, infection, thromboembolic events, or procedure-related issues, were identified, documented, and managed according to institutional guidelines.

Statistical Analysis The null hypothesis stated that there was no difference in intraoperative blood loss between the two groups. The alternative hypothesis proposed a reduction in blood loss with balloon tamponade. Continuous variables were summarised using mean and standard deviation. Categorical variables were presented as frequencies and percentages. Comparison between groups for continuous variables was performed using independent t-test or equivalent non-parametric tests where appropriate. Categorical variables were analysed using chi-square or Fisher's exact test. Association between intervention and outcomes was assessed using appropriate inferential methods. A p-value of less than 0.05 was considered statistically significant. Both statistical and graphical analyses were conducted using Stata version 17.0.

4. Results

Table 1: Baseline Characteristics of Study Participants (n = 60)

Variable	Balloon Tamponade Group (n = 30)	Control Group (n = 30)
Age (years), mean ± SD	28.6 ± 4.2	29.1 ± 4.5
Age Group, n (%)		
<25 years	6 (20.0)	5 (16.7)
25–30 years	14 (46.7)	15 (50.0)
>30 years	10 (33.3)	10 (33.3)
Parity, n (%)		
Primigravida	8 (26.7)	9 (30.0)
Multigravida	22 (73.3)	21 (70.0)
Gestational Age (weeks), mean ± SD	36.8 ± 1.4	36.5 ± 1.6
Gestational Age Category, n (%)		
<37 weeks	11 (36.7)	13 (43.3)
≥37 weeks	19 (63.3)	17 (56.7)
Previous LSCS, n (%)		
None	9 (30.0)	10 (33.3)
One	12 (40.0)	11 (36.7)
Two or more	9 (30.0)	9 (30.0)
Type of Placental Abnormality, n (%)		
Placenta previa	12 (40.0)	13 (43.3)
Placenta accreta	8 (26.7)	7 (23.3)
Placenta increta	6 (20.0)	6 (20.0)
Placenta percreta	4 (13.3)	4 (13.3)
Haemoglobin (g/dL), mean ± SD	10.2 ± 1.1	10.0 ± 1.2

Table 1 shows the baseline characteristics of participants in both groups. The mean age was similar (28.6 ± 4.2 vs 29.1 ± 4.5 years). Most participants were aged 25–30 years in both groups (46.7% vs 50.0%). Multigravida women formed the majority (73.3% vs 70.0%). Mean gestational age was comparable (36.8 ± 1.4 vs 36.5 ± 1.6 weeks), with most patients ≥37 weeks (63.3% vs 56.7%). Distribution of previous LSCS and types of placental abnormality was similar. Mean haemoglobin levels were also comparable (10.2 ± 1.1 vs 10.0 ± 1.2 g/dL).

Table 2: Operative Details among Study Participants (n = 60)

Variable	Balloon Tamponade Group (n = 30)	Control Group (n = 30)	p-value
Duration of Surgery (min), mean ± SD	82.5 ± 14.2	104.3 ± 18.6	<0.001
Incision to Delivery Time (min), mean ± SD	8.6 ± 2.1	9.8 ± 2.5	0.041
Intraoperative Complications, n (%)	3 (10.0)	8 (26.7)	0.092
Intraoperative Hypotension, n (%)	5 (16.7)	14 (46.7)	0.013
Vasopressor Use, n (%)	6 (20.0)	15 (50.0)	0.015

Table 2 shows operative details among participants. The mean duration of surgery was significantly shorter in the balloon group (82.5 ± 14.2 vs 104.3 ± 18.6 minutes; p<0.001). Incision to delivery time was also lower (8.6 ± 2.1 vs 9.8 ± 2.5 minutes; p=0.041). Intraoperative complications were fewer in the balloon group (10.0% vs 26.7%). Intraoperative hypotension (16.7% vs 46.7%; p=0.013) and vasopressor use (20.0% vs 50.0%; p=0.015) were significantly lower.

Table 3: Intraoperative Blood Loss among Study Participants (n = 60)

Variable	Balloon Tamponade Group (n = 30)	Control Group (n = 30)	p-value
Blood Loss (mL), mean ± SD	820 ± 210	1280 ± 320	<0.001
Blood Loss Category, n (%)			
<1000 mL	18 (60.0)	6 (20.0)	
1000–1500 mL	9 (30.0)	10 (33.3)	
>1500 mL	3 (10.0)	14 (46.7)	<0.001

Table 3 shows intraoperative blood loss. Mean blood loss was significantly lower in the balloon group (820 ± 210 vs 1280 ± 320 mL; p<0.001). A higher proportion of patients in the balloon group had blood loss <1000 mL (60.0% vs 20.0%), while severe blood loss >1500 mL was more common in the control group (46.7% vs 10.0%; p<0.001).

Table 4: Postoperative outcome

Variable	Balloon Tamponade Group (n = 30)	Control Group (n = 30)	p-value
Hb Drop (g/dL), mean ± SD	1.6 ± 0.8	3.1 ± 1.2	<0.001
Hospital Stay (days), mean ± SD	5.2 ± 1.4	7.6 ± 2.1	<0.001
Postpartum Haemorrhage, n (%)	3 (10.0)	11 (36.7)	0.018
Postoperative Complications, n (%)	4 (13.3)	10 (33.3)	0.067
ICU Admission, n (%)	4 (13.3)	12 (40.0)	0.02

Table 4 shows postoperative outcomes. Mean haemoglobin drop was lower in the balloon group (1.6 ± 0.8 vs 3.1 ± 1.2 g/dL; p<0.001). Hospital stay was shorter (5.2 ± 1.4 vs 7.6 ± 2.1 days; p<0.001). Postpartum haemorrhage was less frequent (10.0% vs 36.7%; p=0.018). Postoperative

complications were lower (13.3% vs 33.3%), and ICU admission was significantly reduced (13.3% vs 40.0%; p=0.020).

Table 5: Balloon-Related Procedural Outcomes (n = 30)

Variable	Balloon Tamponade Group (n = 30)
Successful Catheter Placement, n (%)	29 (96.7)
Balloon Inflation Duration (min), mean ± SD	46.5 ± 10.2
Procedure-related Complications, n (%)	2 (6.7)

Table 5 shows balloon-related procedural outcomes in the intervention group. Successful catheter placement was achieved in 29 out of 30 patients (96.7%). The mean duration of balloon inflation was 46.5 ± 10.2 minutes. Procedure-related complications were observed in 2 patients (6.7%), indicating a high success rate with relatively low complication occurrence.

5. Discussion

Placental abnormalities, particularly placenta previa and placenta accreta spectrum (PAS), are well recognised causes of severe obstetric haemorrhage and maternal morbidity. These conditions involve abnormal placental attachment or invasion into the uterine wall, which interferes with normal placental separation and results in excessive bleeding at delivery. With increasing caesarean section rates, the incidence of PAS has risen steadily. **Jauniaux E et al., 2018** reported that prior caesarean delivery is one of the strongest risk factors for PAS, highlighting the growing clinical burden of these conditions[10].

The present study assessed the effectiveness of prophylactic bilateral internal iliac artery balloon tamponade in reducing intraoperative blood loss during LSCS. The mean blood loss was 820 ± 210 mL in the balloon tamponade group and 1280 ± 320 mL in the control group, with a statistically significant difference ($p<0.001$). In addition, 60.0% of patients in the intervention group had blood loss less than 1000 mL, compared to only 20.0% in the control group. On the other hand, severe blood loss (>1500 mL) was much higher in the control group (46.7%) than in the balloon group (10.0%). This pattern shows a consistent shift towards lower blood loss in patients who received balloon occlusion.

This reduction in blood loss can be explained by the mechanism of internal iliac artery balloon occlusion. Temporary occlusion reduces pelvic arterial inflow and decreases uterine perfusion at the time of placental separation. This leads to better haemostasis during surgery. **Salim R et al., 2015** described that controlled pelvic devascularisation can significantly reduce intraoperative bleeding in cases of abnormal placentation[11]. **Chen M et al., 2019** observed that patients undergoing prophylactic balloon occlusion had significantly lower intraoperative blood loss compared to those managed with standard surgical care[12]. Their study also showed a reduction in cases with massive haemorrhage, which supports the lower proportion of >1500 mL blood loss seen in the present study. Similarly, **Yu PC et al., 2015** reported that balloon occlusion reduced both mean blood loss and the incidence of severe haemorrhage in placenta accreta cases[13]. Another study by **Tan CH et al., 2017** also demonstrated that prophylactic internal iliac artery balloon placement was associated with lower intraoperative blood loss and reduced need for massive transfusion[14].

However, not all studies have shown uniform benefit. **Sentilhes L et al., 2010** reported no significant reduction in blood loss with prophylactic balloon occlusion[15]. The authors suggested that extensive collateral circulation in the pelvis may limit the effectiveness of internal iliac artery occlusion in some patients. This may explain why a small proportion of patients in the balloon group in the present study still experienced blood loss above 1500 mL. Differences across studies may also be related to variation in patient selection. Balloon occlusion appears to be more effective in patients with severe forms of placental invasion. In less severe cases, the benefit may be limited. In the present study, the inclusion of different types of placental abnormalities could have influenced the variability in blood loss within each group.

Another factor is procedural technique. Timing of balloon inflation, correct catheter positioning, and coordination between surgical and radiology teams are important[16]. In the present study, balloons were inflated after delivery and cord clamping, which is considered an optimal time to reduce bleeding during placental separation. Proper technique may have contributed to the significant reduction in blood loss observed.

In addition to reduced blood loss, the present study showed a significantly shorter duration of surgery in the balloon group. Reduced bleeding improves visibility of the surgical field, allowing quicker identification of tissue planes and more efficient dissection. **Shrivastava V et al., 2007** reported that reduced intraoperative bleeding was associated with shorter operative time and fewer surgical difficulties in PAS cases managed with vascular control techniques[17]. The haemoglobin drop was also significantly lower in the intervention group (1.6 vs 3.1 g/dL). The reduction in haemoglobin drop in the present study is consistent with the reduced intraoperative blood loss.

The incidence of postpartum haemorrhage was significantly lower in the balloon group (10.0% vs 36.7%). This is an important clinical outcome, as postpartum haemorrhage is a major contributor to maternal morbidity and mortality. **Yu PC et al., 2015** demonstrated that prophylactic balloon occlusion reduced the risk of severe postpartum haemorrhage in women with placenta accreta[13]. These findings support the role of balloon tamponade as an effective haemorrhage control strategy.

The need for ICU admission was also lower in the intervention group (13.3% vs 40.0%). ICU admission often indicates severe haemorrhage or haemodynamic instability. Reduced ICU requirement suggests better overall perioperative outcomes. **Zhang L et al., 2021** reported similar findings, where improved haemorrhage control was associated with reduced need for critical care support[16]. Safety of the procedure is another key consideration. In the present study, the success rate of catheter placement was high (96.7%), and complications were minimal (6.7%). However,

rare complications such as arterial thrombosis, limb ischaemia, and vascular injury have been described. These risks underline the need for experienced interventional radiology teams[13,15].

Alternative techniques such as abdominal aortic balloon occlusion have also been explored. **Meng X et al., 2020** reported that aortic balloon occlusion may provide greater reduction in blood loss compared to internal iliac artery occlusion[18]. However, it may also carry higher risk and requires careful monitoring. Therefore, the choice of technique should be individualised based on patient profile and available expertise[19,20]. The present study contributes to the growing evidence supporting the role of interventional radiology in obstetric haemorrhage management. It demonstrates that prophylactic bilateral internal iliac artery balloon tamponade can improve surgical outcomes in patients with placental abnormalities. The findings are particularly relevant in tertiary care centres where multidisciplinary management is possible.

However, certain limitations must be acknowledged. The study had a relatively small sample size and was non-randomised. Group allocation was based on clinical decision and availability of services, which may introduce selection bias. Future research should focus on large randomised controlled trials to establish the true effectiveness of this technique. Standardisation of procedural protocols, including duration of balloon inflation, is also needed. Comparative studies between different vascular control techniques may further clarify the best approach.

6. Conclusion

Prophylactic bilateral internal iliac artery balloon tamponade showed clear benefit in patients with placental abnormalities undergoing caesarean section. It was associated with lower intraoperative blood loss, smaller haemoglobin drop, and shorter duration of surgery. Rates of postpartum haemorrhage and ICU admission were also reduced. The procedure was feasible, with high success and few complications. These findings support its role as a useful adjunct in selected high-risk cases. However, the sample size was limited and allocation was not randomised. Larger studies are needed to confirm these results and to define clear indications for routine clinical use.

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