Scientific Research Publishing

Open Journal of Obstetrics and Gynecology, 2025, 15(7), 1019-1029
https://www.scirp.org/journal/ojog
ISSN Online: 2160-8806
ISSN Print: 2160-8792

Postpartum Hemorrhage: The Benefits of Preventive Triple Vascular Ligation during Cesarean Section at the N'Djamena University Hospital for Mothers and Children in 2025

Sadjoli Damtheou[1,2], Gauthier Regis Jostin Buambo[3*], Esdras Juvenal Mbainaissem[2], Cherif Hawaye[1,2], Kheba Foba[1,2], Allarehene Noudjalbaye[2], Samantha Nuelly Bialay Potokoue Mpia[3], Danmadji Naorgue[1,2], Adanao Hissein[1,2], Bray Madoue Gabkika[1,2], Lhagadang Foumsou[1,2], Clautaire Itoua[3]

[1]Department of Obstetrics and Gynecology, Faculty of Human Health Sciences, University of N'Djamena, N'Djamena, Tchad
[2]Directorate of Obstetrics and Gynecology, N'Djamena University Hospital for Mothers and Children, N'Djamena, Tchad
[3]Department of Obstetrics and Gynecology, Faculty of Health Sciences, Marien NGOUABI University, Brazzaville, Congo
Email: *buambogauthier@yahoo.fr

How to cite this paper: Damtheou, S., Buambo, G.R.J., Mbainaissem, E.J., Hawaye, C., Foba, K., Noudjalbaye, A., Mpia, S.N.B.P., Naorgue, D., Hissein, A., Gabkika, B.M., Foumsou, L. and Itoua, C. (2025) Postpartum Hemorrhage: The Benefits of Preventive Triple Vascular Ligation during Cesarean Section at the N'Djamena University Hospital for Mothers and Children in 2025. *Open Journal of Obstetrics and Gynecology*, **15**, 1019-1029.
https://doi.org/10.4236/ojog.2025.157083

Received: May 13, 2025
Accepted: July 8, 2025
Published: July 11, 2025

Abstract

Objective: To evaluate the contribution of triple vascular ligation in preventing postpartum hemorrhage due to uterine atony during cesarean section at the N'Djamena University Hospital for Mothers and Children. **Patients and Methods:** This was a quasi-experimental, intervention/non-intervention, single-center study comparing 106 cesarean sections at risk of postpartum hemorrhage due to uterine atony who underwent triple Tsirulnikov ligation from July 1 to October 31, 2024, and 106 other cesarean sections who did not receive it from January 1 to June 30, 2024. The primary outcome measure was the occurrence of postpartum hemorrhage. The p-value for the probability was considered significant at a value < 5%. **Results:** Postpartum hemorrhage accounted for 12.3% of cases (26/212). Triple vascular ligation reduced the risk of postpartum hemorrhage by 70% (3.7% vs. 20.7%; RR = 0.3 [0.05 - 0.45]; p < 0.05) and prevented it in 40% of patients (RD = −39.5). Forty patients had to undergo triple preventive ligation for one case of postpartum hemorrhage due to uterine atony to occur (NNT = 40%). **Conclusion:** Triple vascular ligation reduces the risk of postpartum hemorrhage during caesarean section, regardless of the patient's age, though the efficacy varies depending on the risk of hemorrhage.

Keywords

Postpartum Hemorrhage, Cesarean Section, Vascular Ligations, Prevention, N'Djamena

1. Introduction

Postpartum hemorrhage (PPH) is defined as cumulative blood loss of 1000 ml or blood loss accompanied by signs or symptoms of hypovolemia within 24 hours of the birth process (including intrapartum blood loss), regardless of the mode of delivery [1] [2]. The causes of PPH are multiple and may be associated. The most common is uterine atony, followed in descending order by retained placenta, placental insertion abnormalities, soft tissue hemorrhage, and constitutional or acquired hemostatic disorders [3]. PPH is responsible for 135,000 maternal deaths per year worldwide [4]. With a rate of 860 per 100,000 live births in 2020, Chad is one of the nine countries with the highest maternal mortality rates. Most of these deaths are caused by severe hemorrhage after childbirth [4]. The management of postpartum hemorrhage is codified and multidisciplinary, involving obstetricians and anesthesiologists/resuscitators. It is an emergency that requires the mobilization of resuscitation measures and comprehensive emergency obstetric care (uterotonics, uterine evacuation, artificial delivery, blood transfusion) [5]. Failure of initial management or the severity of the hemorrhage often necessitates uterine artery embolization or conservative surgical treatment (plication, compression, vascular ligation) or radical treatment (hysterectomy for hemostasis) [6]-[9]. Hemostatic hysterectomy is one of the most performed surgical procedures in our maternity wards and is associated with high morbidity and mortality rates due to the poor general condition of patients and the unavailability of blood products, which remains a challenge in our countries [6] [10]. Conservative surgery for PPH remains an alternative to hysterectomy, with proven efficacy of vascular ligatures [11] [12]. However, it is not recommended for the prevention of postpartum hemorrhage. To this end, the management of hemorrhage during delivery in our maternity wards should focus on preventive measures, both vaginal (active management of the third stage of labor) and intrauterine (vascular plication or ligation techniques). This study therefore aimed to evaluate the contribution of triple vascular ligation in the prevention of hemorrhage during delivery due to uterine atony during cesarean section in patients at the University Mother and Child Hospital in N'Djamena.

2. Patients and Method

This was a quasi-experimental intervention/non-intervention study conducted in the maternity ward of the University Mother and Child Hospital in N'Djamena, comparing cases of cesarean sections with a risk of hemorrhage during delivery due to uterine atony that underwent Tsirulnikov triple ligation between July 1 and

October 31, 2024 (Intervention Group) and those that did not undergo this procedure between January 1 and June 30, 2024 (Control Group). The two groups were matched on:

- age: 15 to 19 years, 20 to 34 years, and 35 to 49 years;
- bleeding risk: low, moderate, and high [13]-[15].

Performed abdominally, Tsirulnikov's triple ligation involved bilateral ligation of the uterine arteries, round ligament arteries, and utero-ovarian ligaments [9].

2.1. Inclusion Criteria

The following patients were included in both groups:

- those with a pregnancy of 28 weeks or more of amenorrhea based on the date of the last menstrual period or early ultrasound;
- regardless of the number of fetuses;
- having received Misoprostol as a preventive measure in 600 microgram tablets sublingually or 1000 micrograms intrarectally.

2.2. Exclusion Criteria

Patients who had intraoperative hemoperitoneum, were taking anticoagulant therapy, or had confirmed congenital coagulopathy were excluded from the study.

2.3. Sampling

It was exhaustive for the Intervention group and simple random without replacement for the Control group.

The sample size was calculated using Kelsey Fleiss's formula [16] [17].

Using data from M Kehila's 2016 study [12] on "What surgical strategy should be adopted for postpartum hemorrhage and how can the results of hypogastric artery ligation be improved?", p1 corresponds to the success rate of bilateral hypogastric artery ligation (BHAL) in cases of coagulation disorders (p1 = 57.1%) in this study, and p2 corresponds to the success rate of BHAL in cases without coagulation disorders.

The minimum sample size for statistical analysis was 82, *i.e.*, 82 cases for the intervention group and 82 cases for the control group.

2.4. Outcome Criteria

This referred to the occurrence of hemorrhage within 24 hours of cesarean section, abnormal in that it exceeded 500 ml or had an impact on the mother's general condition (pallor and hemodynamic status).

2.5. Study Variables

The variables studied were:

- preoperative: sociodemographic (age, paid work, level of education, place of residence, socioeconomic status), reproductive (number of pregnancies, parity, history of miscarriage), clinical (mode of admission, medical history, uterine scar, history of postpartum hemorrhage, monitoring of the current pregnancy, risk of hemorrhage);
- postoperative: postpartum hemorrhage, pallor, hemodynamic status.

2.6. Statistical Analysis

SPSS 26 software was used for statistical analysis. Pearson's chi-square test and Fischer's exact test were used to compare proportions, and Student's t-test and Mann-Whitney test were used to compare means and medians, respectively. The following statistical measures were calculated to evaluate the contribution of triple vascular ligation:

- relative risk (RR) and its 95% confidence interval estimated at a significance level of less than 5%;
- relative risk difference (RRD) to determine the proportion of women who underwent cesarean section and avoided postpartum hemorrhage because of triple vascular ligation;
- relative risk reduction (RRR), which assesses the reduction in the frequency of postpartum hemorrhage in women who underwent cesarean section and received triple ligation compared to the control group;
- number needed to treat (NNT), which corresponds to the number of patients who need to undergo triple ligation for one case of postpartum hemorrhage to occur.

3. Results

During the study period, 106 patients at risk of PPH who underwent cesarean section were enrolled in each group and matched for age and hemorrhagic risk. PPH accounted for 12.3% of cesarean sections (26/212). Triple vascular ligation reduced the risk of PPH by 70% and prevented it in 40% of patients. Forty patients had to undergo preventive triple ligation before a case of postpartum hemorrhage due to uterine atony occurred (Table 1).

Among the 48 cases of caesarean section aged 15 to 19 years, none presented postpartum haemorrhage in the intervention group, compared to 3 cases of haemorrhage in the control group, although the difference was not statistically significant (Table 2).

In patients aged 20 to 34 and 35 to 49 years, the risk of postpartum hemorrhage was low in the intervention group. Triple preventive vascular ligation had a beneficial effect, preventing postpartum hemorrhage in 34% and 59% of cases in 20 to 34 and 35- to 49-year-olds, respectively. It resulted in a relative reduction in the frequency of postpartum hemorrhage of 65% and 80% in 20 to 34 and 35- to 49-year-olds, respectively (Table 3 and Table 4).

Table 1. Contribution of preventive triple vascular ligation during cesarean section.

Variables	Intervention (N = 106)		Control (N = 106)		RR (CI [95%])	p	RD	RRR	NNT
	n	%	n	%					
Postpartum hemorrhage	4	3.7	22	20.7	0.3 [0.05 - 0.45]	0.0001	−39.5	70	40
Severe bleeding	3	75	12	54.5	-	-	-	-	-
Moderate bleeding	1	25	10	45.5					
Conjunctival pallor	12	11.3	24	22.6	0.6 [0.21 - 0.93]	0.02	−20	40	20
Hemodynamic stability	103	97.2	94	91.3	2.6 [1.9 - 7.2]	0.001	32.3	-	-

Table 2. Benefits of preventive triple vascular ligation in patients aged 15 to 19 years.

Variables	Intervention (N = 22)		Control (N = 26)		
	n	%	n	%	
Postpartum hemorrhage	0	0	3	11.5	0.1
Severity of hemorrhage					0.1
Severe bleeding	0	0	1	33.3	
Moderate bleeding	0	0	2	66.7	
Bleeding time: 30-60 min	0	0	3	100	-
Conjunctival pallor	2	9.1	2	7.6	0.6
Hemodynamic stability	22	100	25	96.2	0.5

Table 3. Benefits of preventive triple vascular ligation in patients aged 20 to 34.

Variables	Intervention (N = 64)		Control (N = 67)		RR (CI [95%])	p	RD	RRR	NNT
	n	%	n	%					
Postpartum hemorrhage	3	4.7	13	19.4	0.35 [0.05 - 0.7]	0.01	−34	65	35
Severity of hemorrhage					-	0.3	-	-	-
Severe bleeding	2	66.7	7	53.8					
Moderate bleeding	1	33.3	6	46.2					
Bleeding time (min)									
[30 - 60]	1	33.3	10	77	-	-	-	-	-
>60	2	66.7	3	23	-	-	-	-	-
Conjunctival pallor	8	12.5	15	22.4	-	0.1	-	-	-
Hemodynamic stability	62	96.8	60	89.5	-	0.09	-	-	-

In patients at low risk of hemorrhage, no postpartum hemorrhage was noted in the intervention group compared to 10.2% in the control group with a significant difference (Table 5). Furthermore, in cases of moderate to high risk, triple preventive ligation prevented the occurrence of postpartum hemorrhage in almost 42% and had a significant beneficial effect on the hemodynamic state (Table 6).

4. Discussion

Postpartum hemorrhage (PPH), whose main cause is uterine atony, is one of the leading causes of maternal mortality due to obstetric hemorrhage, accounting for more than a quarter of maternal deaths [3]. Occurring primarily in cases of vaginal delivery, its frequency after cesarean section varies according to authors and

Table 4. Benefits of preventive triple vascular ligation in operated women aged 35 - 49.

Variables	Intervention (N = 20)		Control (N = 13)		RR (IC [95%])	p	DR	RRR	NNT
	n	%	n	%					
Postpartum hemorrhage	1	5	6	46.2	0.2 [0.01 - 0.59]	0.01	−58.8	80	59
Severity of hemorrhage						0.06	-	-	-
Severe bleeding	1	100	4	66.7		-	-	-	-
Moderate bleeding	0	0	2	33.3					
Bleeding time (min)									
[30 - 60]	1	100	5	83.3	-	-	-	-	-
>60	0	0	1	16.7	-	-	-	-	-
Conjunctival pallor	1	5	9	69.2	0.12 [0.01 - 0.21]	0.001	−72.6	88	71
Hemodynamic stability	19	95	9	69.2	-	0.06	-	-	-

Table 5. Benefits of triple vascular ligation in parturients at low risk of bleeding.

Variables	Intervention (N = 52)		Control (N = 59)		p
	n	%	n	%	
Postpartum hemorrhage	0	0	6	10.2	0.02
Severity of hemorrhage					0.8
Severe bleeding	0	0	2	33.3	-
Moderate bleeding	0	0	4	66.7	
Bleeding time (min)					
[30 - 60]	0	0	4	66.7	-
>60	0	0	2	33.3	-
Conjunctival pallor	2	3.8	6	10.2	0.1
Hemodynamic stability	52	100	57	96.6	0.2

Table 6. Benefits of triple vascular ligation in parturients at moderate to high risk of bleeding.

Variables	Intervention (N = 54)		Control (N = 47)		RR (IC [95%])	p	RD	RRR	NNT
	n	%	n	%					
Postpartum hemorrhage	4	7.4	16	34	0.3 [0.05 - 0.5]	0.001	−41.7	70	42
Severity of hemorrhage					-	0.6	-	-	-
Severe bleeding	3	75	10	62.5					
Moderate bleeding	1	25	6	37.5					
Bleeding time (min)									
[30 - 60]	2	50	14	87.5	-	-	-	-	-
>60	2	50	2	12.5		-			
Conjunctival pallor	10	18.5	18	38.3	0.6 [0.15 - 0.9]	0.02	−24.5	40	25
Hemodynamic stability	51	94.4	37	78.7	2.5 [1.2 - 17.8]	0.01	34.8	-	-

methodological approaches: 1.7% in Gabon [18]; 7.5% in Burkina Faso [19]; 10.6% in Mali [20] and 16.36% to 17.56% between 2015 and 2019 in France [21]. In our study, it was 12.3%. Given its severity and associated morbidity and mortality, PPH is an obstetric emergency that requires immediate treatment without delay in diagnosis.

Several guidelines developed by Western learned societies on the management of postpartum hemorrhage due to uterine atony recommend the initial use of uterotonic agents and uterine embolization or laparotomy in cases of failure of medical treatment or severe hemorrhage [22] [23].

In sub-Saharan Africa, the limited technical facilities available do not allow for interventional radiology, prompting teams to perform laparotomy for conservative surgery (plication, vascular ligation) or radical surgery (hysterectomy for hemostasis). Several authors, for reasons related to technical expertise or surgical experience, have reported a preference for plication techniques (B-Lynch) or vascular ligation in the management of postpartum hemorrhage due to uterine atony in a population with an average age of 30 years and few previous births [18]-[20] [24].

The Canadian Society of Obstetricians and Gynecologists recommends using a checklist to record the individualized assessment of the risk of postpartum hemorrhage upon admission to the birth unit and throughout labor [22]. Thus, by assessing the risk of hemorrhage associated with uterine atony in women who had undergone cesarean section, we compared cases of cesarean section in which Tsirulnikov's triple vascular ligation was performed with those in which it was not. This was done to evaluate the contribution of preventive vascular ligation to the occurrence of postpartum hemorrhage due to uterine atony.

The frequency of postpartum hemorrhage in women who underwent Tsirulnikov triple vascular ligation was five times lower than in the control group among

women of childbearing age, with a 40% difference in the risk of hemorrhage and a 70% reduction in risk in the ligation group. In a Malian study on obstetric outcomes after uterine plication in the treatment of immediate postpartum hemorrhage (IPPH) due to uterine atony, the frequency of IPPH after cesarean section was 5% [20] with a success rate of uterine plication of 91.35%, corroborating the results of Okon G in Côte d'Ivoire [24]. Despite control of hemorrhage in most cases, the authors of these series each reported three deaths [20] [24].

In cases of atony, the success rate of embolization and uterine pedicle ligation varies between 80% and 100% [8] [25] [26]. Ligation of the internal iliac arteries is undoubtedly slightly less effective and more difficult to perform from a technical standpoint, but its success rate is greatly improved when performed early or in combination with another conservative technique [11] [12] [27]. It remains an interesting option in obstetric traumatic lesions that do not involve the uterus. In cases of bleeding from the lower segment during a cesarean section, low ligation of the uterine arteries is required. All these methods are more effective when performed early, before the onset of major coagulation disorders. In such cases, uterine devascularization must also be applied to the lumbosacral pedicles [8].

In Africa, deaths from postpartum hemorrhage mostly happen because of a bunch of things, like delays in getting to the right place and getting help, and surgery done when someone is in shock from losing a lot of blood, which can be hard to fix because blood products aren't always available [6] [10] [18] [19]. This is a real therapeutic challenge in our maternity wards, where care should be more focused on preventing postpartum hemorrhage. While active management of the third stage of labor (AMTSL) is strongly recommended to prevent postpartum hemorrhage in vaginal deliveries [4], targeted preventive vascular ligation should be equally recommended in cesarean deliveries in low-resource maternity wards. However, the literature review remains limited and guidelines on the subject are lacking. Our study demonstrated the benefit of preventive triple vascular ligation in cesarean section patients, with a positive effect regardless of age and the risk of hemorrhage associated with uterine atony.

This study allowed us to demonstrate the effectiveness of triple vascular ligation in preventing PPH in patients at risk of postpartum hemorrhage who underwent cesarean section, compared to a control group that did not receive this intervention. The objective was not to treat PPH but rather to prevent it in a high-risk population during cesarean section.

Although the two groups were matched for age and bleeding risk, and in the control group, patients were selected after randomization to manage selection bias, there may be other factors unrelated to the intervention that could influence the results. This could make it difficult to isolate the effect of the intervention and determine its actual influence.

Furthermore, due to the specific characteristics of the participants and the context of the study, our results may not be easily generalizable to other populations or groups with characteristics different from those of the patients studied.

5. Conclusion

Triple vascular ligation reduces the risk of postpartum hemorrhage during caesarean section, regardless of the patient's age, though the efficacy varies depending on the risk of hemorrhage. Further multicenter studies with more rigorous methodology and a larger sample size are essential to better manage bias and generalize the practice of preventive triple vascular ligation during caesarean sections in all patients at risk of hemorrhage.

Authors' Contribution

All authors contributed to the conception, writing and validation of the manuscript.

Acknowledgements

Within the framework of bilateral cooperation between the coordination of Specialized Studies Diplomas in Gynaecology and Obstetrics at our two universities, the Teaching and Research Unit of Gynaecology and Obstetrics at the Faculty of Health Sciences of Marien NGOUABI University is offering a course.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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