ORIGINAL PAPER

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Motivation for conducting the study: To describe the outcomes of initial surgical management of postpartum hemorrhage due to uterine atony.

Main findings: The use of compressive sutures is associated with a lower decrease in hemoglobin in patients with postpartum hemorrhage due to uterine atony.

Implications: The use of compressive sutures will allow management of postpartum hemorrhage for less hemoglobin depletion and less need for transfusions.

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Compressive sutures are associated with less hemoglobin depletion in postpartum hemorrhage due to uterine atony

Las suturas compresivas se asocian a una menor disminución de hemoglobina en la hemorragia posparto por atonía uterina

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ABSTRACT

Objectives: To determine the association between the use of compressive sutures and the decrease in hemoglobin at 24 hours in post cesarean section patients diagnosed with postpartum hemorrhage (PPH) due to uterine atony. Materials and methods: Retrospective cohort analytical study in 625 postoperative patients diagnosed with postpartum hemorrhage due to uterine atony in a national maternal perinatal institute between July and December 2020. The association was evaluated by t student and multiple linear regression determining the crude and adjusted association using confounding variables. Results: A total of 157 medical records were included in the analysis. The mean age was 29.1 ± 6.6 years, median body mass index 30.5 kg/m2 and median prenatal care was 2. No adverse events were reported for the use of compressive sutures. The use of compressive sutures was associated with a lower 24-h hemoglobin decrease of 0.37 mg/dL (95% CI -0.73; -<0.01, p=0.045) on average, controlled for confounding variables. Conclusions: Compressive suturing is an effective first-line surgical procedure in the surgical management of PPH. No adverse events were found in the study population. The use of compressive sutures had on average a lower decrease in hemoglobin at 24 hours compared to the non-use of compressive sutures.

Key words: Postpartum hemorrhage, Atony, uterine, Suture techniques, Hemoglobin

RESUMEN

Objetivos. Determinar la asociación entre el uso de suturas compresivas y el descenso de hemoglobina a las 24 horas en pacientes poscesárea con diagnóstico de hemorragia posparto (HPP) por atonía uterina. Materiales y métodos. Estudio analítico de cohorte retrospectiva en 625 pacientes postoperadas con diagnóstico de hemorragia posparto por atonía uterina en un instituto nacional materno perinatal entre julio y diciembre del 2020. Se evaluó la asociación mediante t student y regresión lineal múltiple determinando la asociación cruda y ajustada usando variables confusoras. Resultados. Se incluyó en el análisis 157 historias clínicas. La media de la edad fue 29,1 ± 6,6 años, la mediana de índice de masa corporal 30,5 kg/m2 y la mediana de cuidado prenatal fue de 2. No se comunicó eventos adversos por el uso de las suturas compresivas. El empleo de suturas compresivas estuvo asociado a una menor disminución de la hemoglobina en 24 h, de 0,37 mg/dL (IC 95% -0,73; -<0,01, p=0,045) como promedio, controlado por variables confusoras. Conclusiones. La sutura compresiva es un procedimiento quirúrgico efectivo de primera línea en el manejo quirúrgico de HPP, No se encontró eventos adversos en la población de estudio. El uso de suturas compresivas tuvo en promedio un menor descenso de la hemoglobina a las 24 horas en comparación al no uso de suturas compresivas.

Palabras clave. Hemorragia posparto, Inercia uterina, Técnicas de sutura; Hemoglobina

Introduction

Postpartum hemorrhage (PPH) is the leading cause of maternal mortality worldwide[1,2] and contributes 19.7% of maternal deaths[3]. In Peru, 264 maternal deaths occurred in 2023, of which 21.8% were due to obstetric hemorrhage[4].

The definition of PPH is not yet fully standardized mainly due to the difficulty of blood quantification[5]. The World Health Organization

(WHO), in 2014 classically defined PPH as blood loss of 500 mL consecutive to vaginal delivery or more than 1,000 mL after cesarean section, within 24 hours after delivery. It is also defined as any postpartum bleeding with hemodynamic changes requiring blood transfusion, a drop in hematocrit of more than 10%[6] and/or 2.9 mg/dL in hemoglobin[7]. In 2007, the American College of Obstetrics and Gynecology defined it as a loss greater than or equal to 1,000 mL associated with signs or symptoms of hypovolemia, independent of the type of delivery[5]. The global prevalence of PPH, independent of the route of delivery, in observational studies is 10.8%, in Africa 25.7% and in Latin America and the Caribbean 8.2%[8]. In Peru, Cabrera et al. published a prevalence of 10%[9].

The main cause of PPH is uterine atony[2], which is conditioned by various characteristics of pregnancy, delivery and puerperium. The most representative risk factors for PPH due to uterine atony are multiparity[10], previous cesarean section[11], hypertensive disorders associated with pregnancy[12], polyhydramnios[13], chorioamnionitis[13], multiple pregnancy[10], fetal macrosomia[10,12], body mass index ≥ 28 kg/m2[10], maternal age greater than or equal to 35 years[14], among others. Therefore, PPH prevention should focus on the early detection of risk factors and the planning of specific measures within delivery care.

The management of PPH recommended by various organizations includes intravenous isotonic crystalloids, uterine massage, uterotonic drugs and the use of tranexamic acid as initial measures[15]. When medical treatment fails, the use of conservative surgical measures such as B-Lynch and Hayman compressive sutures[16], which generate mechanical compression of the uterine walls, significantly reducing postpartum hemorrhage bleeding and preventing its recurrence, is recommended. Compressive sutures have also been recommended as PPH prophylaxis in high-risk cesarean section patients, achieving a lower drop in hemoglobin level compared to those receiving medical treatment[17].

PPH is one of the main causes of postpartum anemia, with a prevalence of 10% to 30% in high-income countries and more than 50% in low-resource countries[18]. Postpartum anemia leads to symptoms such as fatigue, palpitations, dyspnea, and infections[19] and may affect the mother-child relationship and care[20]. The use of compressive sutures could be a preventive measure for postpartum anemia in patients with specific risk factors, such as antepartum anemia. Therefore, it would contribute to improve the quality of life of these postpartum women, avoiding compromising the affective bonds between the mother and the newborn and even avoiding blood transfusions.

The aim of the present study was to determine the association between the use of compressive suture and the level of hemoglobin decrease in patients who underwent cesarean section and who presented postpartum hemorrhage due to uterine atony.

Methodology

This was an analytical retrospective cohort study that included all patients who were delivered by cesarean section and had PPH due to uterine atony at the Instituto Nacional Materno Perinatal (INMP) in Lima-Peru, in the period between July and December 2020. The INMP is a tertiary care hospital whose mission is to provide highly specialized care to women, particularly high-risk pregnant women and their newborns. It attends about 16,500 deliveries per year and is a reference center in Peru. The inclusion criteria for the study were: 1) patient whose cesarean delivery took place at the INMP in the determined period; 2) pregnancy greater than 22 weeks; 3) PPH that met one of the following criteria: uterine atony, Hb decrease of 2.9 mg/dL measured at 24 hours postpartum, hematocrit decrease of 10% or intraoperative bleeding of 1,000 mL. Exclusion criteria were placenta previa, placenta accreta spectrum, placental abruption, uterine rupture, coagulation disorders, perineal tear or major vaginal laceration causing PPH, collagenopathies or connective tissue diseases, or diagnoses other than uterine atony; in addition, incomplete medical history records. The present study had the institutional approval of the Ethics Committee with Report N°050-2021-CIE/INMP.

A total of 625 medical records with a diagnosis of PPH according to ICD-10 corresponding to the study period and which met the inclusion criteria and did not have any exclusion criteria were evaluated. Of the total, 461 patients did not meet the inclusion criteria, six patients had a di-

agnosis of PPH other than uterine atony and one patient was excluded due to incomplete data. An electronic data collection instrument constructed in Microsoft Excel version 16.61.1 was applied. The following variables were collected: age, body mass index (BMI), number of adequate prenatal controls greater than or equal to 6 (aPNC)[21], hemoglobin decrease as a result of the difference between antepartum hemoglobin and postpartum hemoglobin at 24 hours, fetal macrosomia (weight ≥4,000 g), twin pregnancy, previous cesarean section, previous postpartum hemorrhage, poor attitude of presentation, uteroplacental insufficiency, severe preeclampsia, eclampsia, cephalopelvic incompatibility, premature detachment of ovarian membranes, use of compressive suture, surgical reintervention, need for prepartum and intrapartum transfusion, need for postpartum transfusion, and operative time.

Continuous variables were presented as mean and standard deviation if they met the normal distribution and median with interquartile ranges if they did not meet the normal distribution. Categorical variables were education, prenatal care (adequate, inadequate PNC), gestational age (preterm or term), categorized body mass index (BMI), parity, use of compressive sutures, number of pregnancies (primigestation, multigestation), number of cesarean sections (primary, equal to or greater than one cesarean section), and surgical reintervention. The variables expressed as continuous variables were age, BMI in kg/m2, number of PNC, pre- and intrapartum globular pack transfusions, postpartum globular pack transfusions and surgical time.

The bivariate analysis was performed with T student with equal variances for numerical independent variables and chi-square for categorical independent variables. Multivariate linear regression controlled for confounding variables according to epidemiological criteria was applied in the analysis. A 95% significance level and Stata statistical software version 17.0 were used for the analysis. In addition, we evaluated multicollinearity in the final model. It should be noted that the study variables complied with the assumptions established in multivariate linear regression: 1) linearity between hemoglobin reduction and the use of compressive sutures was assessed; 2) normality was assessed using Kendall's standard residual density and graphical methods; 3) independence of observations was described; and 4) homoscedasticity was assessed.

Results

The analysis included 157 patients with a diagnosis of PPH due to uterine atony. Table 1 describes the characteristics of the included patients. The mean age was 29.1 years and median BMI 30.5 kg/m2 (type I obesity). Only 12.1% of patients had adequate prenatal care with a median of 2 controls per pregnant woman. The frequency of compressive suture use was 59.9% and no complications directly associated with the surgical procedure were reported. The mean decrease in hemoglobin at 24 hours was 3.25 ± 1.2 mg/dL. The 7 patients who were reoperated did not

Table 1. Sociodemographic and obstetric characteristics (n=157).

Characteristics	n %	Mean ± SD / Median (range)
Age (years)		29.1 ± 6.6
Education (Complete)**		
Primary	9 (5.8)	
Secondary	88 (56.4)	
Superior	21 (13.5)	
BMI (kg/m²)*		30.5 (27.6 - 34.2)
PNC		
Adequate	19 (12.1)	
Inadequate	138(78.9)	
Morbidity**		
Hypertension	5 (3.7)	
Diabetes	2 (1.3)	
Covid-19	8 (5.1)	
Gestational age		
Preterm < 37 wk	49 (31.2)	
At term ≥ 37 wk	108 (68.8)	
Parity		
Multiparous	56 (35.7)	
Primiparous	101 (64.3)	
Compressive suture		
Yes	94 (59.9)	
No	63 (40.1)	
Surgical time (minutes)*		52 (43 - 67)
Reintervention	7 (4.6)	
Admission to ICU	11 (7.0)	
Hb decrease (24 h)**	152	3.25 ± 1.2

SD=standard deviation, BMI=body mass index, PNC=prenatal care, wk=weeks, ICU=intensive care unit
** Variables do not meet normal distribution*
*** Some variables may add up to less than 157 due to missing data*

undergo compressive suturing. Eleven patients (7.0%) were admitted to the intensive care unit (ICU), of whom 63.6% required the use of compressive suturing.

Table 2 shows the main causes of cesarean section in the study. Fetal macrosomia was the most frequent reason with 27 cases (17.2%). Other factors were fetal distress in 26 cases (16.6%) and severe preeclampsia with 23 cases (14.7%).

Table 3 shows the crude and adjusted association of the use of compressive suture and hemoglobin decrease at 24 h. At 24 h, there was less hemoglobin loss. At 24 h, there was lower mean Hb loss of 0.38 mg/dL (95% CI: -0.75, -0.10, *p*=0.044) in those patients who underwent compression suturing controlled for surgical reintervention, pre- and cesarean pack transfusions, post-cesarean pack transfusions, age, BMI and number of prenatal controls.

Table 2. Leading cause of cesarean section (n=157).

Causes	n	%
Fetal macrosomia	27	17.2
Fetal distress	26	16.6
Severe preeclampsia	23	14.7
Previous cesarean >1 time	12	7.6
Breech	11	7.0
Premature detachment of membranes (PPD)	9	5.7
Cephalopelvic incompatibility (CPI)	9	5.7
Multiple pregnancy	5	3.2
Eclampsia	4	2.6
Bad attitude of presentation	4	2.6
Uteroplacental insufficiency	4	2.6
Other*	23	14.7

** Other causes of cesarean section: oligohydramnios, preterm labor, placenta previa, narrow pelvis, chorioamnionitis, prolapsed fetal parts, funicular dystocia and dysfunctional labor.*

Compressive suture was the independent variable and explained approximately 3% of the variability of hemoglobin decrease. However, when confounding variables were added according to epidemiological criteria -such as transfusion of globular packet before and during cesarean section- they increased by 15.9%, transfusion of globular packet after cesarean section by 15.4%, surgical time 14.9%, age 14.5%, categorized BMI by 14.1% and adequate prenatal controls by 13.7%, as the final model. In this final model, multicollinearity was evaluated, which resulted in 1.08, determining that there was no multicollinearity. Finally, homogeneity of variances was tested.

Discussion

In our study we determined the association of lower hemoglobin decrease at 24 hours with the use of a compressive suture surgical technique (B-Lynch or Hayman) in post-cesarean patients with PPH due to uterine atony.

The prevalence of PPH, considering 2,394 cesarean deliveries due to uterine atony between July

Table 3. Multiple linear regression of the association between Hb decrease (24 h) and the use of compressive suture.

Characteristics	Simple linear regression			Multiple linear regression*		
	Coefficient	CI 95%	*p*	Coefficient	CI 95%	*p*
Compressive suture						
No	Ref			Ref		
Yes	- 0.4	-0.77 - -0.017	0.041	0.37*	-0.73 - -0.008	0.045
Preoperative or intraoperative red cell transfusion	Ref			Ref		
	0.47	0.29 - 0.66	<0.001	0.46	0.26 - 0.65	<0.001
Postoperative red cell transfusion	Ref			Ref		
	0.10	-0.06 - 0.26	0.222	-0.01	-0.20 - 0.17	0.878
Surgical time	Ref			Ref		
	<0.01	-<0.01 -<0.01	0.500	<0.01	0.01 - <0.01	0.594
Age	Ref			Ref		
	0.02	-0.01 - 0.05	0.185	<0.01	-0.02 - 0.03	0.641
Body mass index (BMI)	Ref			Ref		
	-0.01	-0.05 - 0.02	0.536	-0.01	-0.04 - 0.02	0.531
Adequate prenatal care (PNC)	Ref			Ref		
	0.05	-0.52 - 0.62	0.856	0.15	-0.39 - 0.70	0.581

CI=95% confidence interval, PG pre/intra SOP=transfusions of globular packs intra or pre operating room, PG post SOP=transfusions of globular packs post operating room
**Adjusted for preoperative/intraoperative PG transfusions, postoperative transfusions, operative time, age, BMI and categorized PNC*

and December 2020, was 6.6%, similar to other studies performed in Peru[9]. The COVID-19 pandemic that conditioned less access to health services among pregnant women does not seem to have affected this prevalence. PPH represented 36.2% in the INMP, being the main cause of extreme maternal morbidity[22].

Only 12.1% of patients in our study had adequate PNC; however, this differs greatly from the 88.9% reported in the 2017 ENDES[23]. This could reflect pandemic-specific limitations that restricted access to care in health facilities. Ninety-three percent of patients diagnosed with PPH were overweight or had a degree of obesity, and 21% of patients had type II or III obesity, similar to other studies[24]. Liu et al. in 2021 published that 36.9% of patients who had PPH were aged 35 years or older; in our study it was 22.3%[25].

Compressive sutures type B-Lynch and Hayman are widespread, easy and reproducible surgical techniques because no special materials are needed for their development, so they can be used in low-resource settings. Basic training given in a standard obstetric medical residency program is required. However, Bouet et al. in 2019 reported that 79% of resident physicians surveyed in France did not effectively master the technique of compressive sutures and 55% had no technique for PPH resolution[26]. Therefore, training programs should ensure that resident physicians attain the necessary competencies in surgical techniques for the management of PPH. Both B-Lynch and Hayman compression sutures are considered to have equal efficacy in the management of PPH[27]. Our study achieved 100% efficacy similar to publications such as the original study by B-Lynch et al[28].

PPH and puerperal anemia constitute a public health problem worldwide and in our country. In addition to causing maternal mortality, puerperal anemia conditions the reduction of quality of life due to the increase of symptoms such as fatigue, palpitations and risk of infections such as those of the urinary tract[19]. In addition, cognitive performance is affected, and there is an increased risk of emotional instability and depression[29]. Therefore, the application of all strategies to prevent, diagnose and treat PPH should be considered. The application of medical treatment with uterotonics is essential; however, Ahmed et al. reported a better effectiveness of compressive suture (B Lynch) compared to medical treatment in terms of hemoglobin and hematocrit reduction in patients with risk factors[17]. Furthermore, it should be noted that Kwong et al. in a prospective study in 2023 concluded that compressive sutures do not alter fertility or menstruation[30]. Consequently, the use of accessible surgical techniques could be to reduce postpartum anemia in patients with risk factors and will be treatment in patients with PPH due to atony.

Among our limitations we consider: 1) The present study is a retrospective cohort, whose data collection depends largely on what is recorded by the treating physicians; 2) There is difficulty in correctly accounting for intraoperative and postoperative bleeding in operative reports and medical records; this could lead to underestimated or overestimated diagnoses; 3) The decrease of 0.3 mg/dL is not clinically significant; but this amount could be related to the difficulty to adequately account for bleeding and the recommendation of a control hemoglobin sample at 48 hours[19]; 4) The statistical power found was around 60%. Therefore, we consider that prospective cohort studies are necessary, with a larger population and study time, with a correct accounting of intraoperative and postoperative bleeding, properly filled out operative reports and data adequately recorded in a validated data collection form.

Conclusions

Compressive suture is a first-line surgical procedure for the treatment of PPH, which would achieve a lower decrease in hemoglobin in postcesarean patients diagnosed with PPH due to uterine atony.

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