



<https://doi.org/10.24245/gom.v92i2.9405>

Prevention of postpartum hemorrhage among women at risk using uterine artery ligation technique during cesarean section.

Prevención de hemorragia posparto durante la cesárea mediante ligadura de las arterias uterinas en pacientes con factores de riesgo

Edgar Nucamendi Solis,¹ José Manuel Chávez Reyes,² Nataly Jazmín Long Morales,² Luis Ernesto Hernández Gamboa,³ Sury Antonio López Cancino⁴

Abstract

OBJECTIVE: To evaluate the preventive benefit of bilateral uterine artery ligation in patients at risk of postpartum hemorrhage, after C-section.

MATERIALS AND METHODS: Prospective, experimental, randomized, case-control, longitudinal, comparative study, carried out during 2022, where patients at risk of postpartum hemorrhage after emergency C-section were included. Two groups were made: the experimental group who underwent bilateral ligation of uterine arteries, and the control group, who only had the C-section. Before and after the surgical procedure, blood loss, and hemoglobin and hematocrit parameters were measured, and compared between the two groups.

RESULTS: Ninety-one patients were studied, 45 in the experimental group, and 46 in the C-section group. Significant differences were found in blood loss of the experimental group (345.56 ± 64.69 mL), vs the control group (426.06 ± 125.49 mL; $p = 0.000247$), hemoglobin parameters (experimental group: 11.13 ± 1.62 g/dL; control group: 10.49 ± 1.32 g/dL, $p = 0.037$), and hematocrit parameters (experimental group: 33.86%; control group: 31.87%; $p = 0.017$).

CONCLUSION: The bilateral ligation of uterine arteries in patients at risk of post C-section hemorrhage is an effective preventive measure which helps to reduce blood loss. Combined with uterotonics, it reduces the volume of bleeding.

KEYWORDS: Uterine artery; Risk factors; Postpartum hemorrhage; Pregnancy; Hematocrit; Hemoglobin.

Resumen

OBJETIVO: Evaluar la utilidad preventiva de la ligadura bilateral de las arterias uterinas en pacientes con factores de riesgo de hemorragia posparto, luego de cesárea.

MATERIALES Y MÉTODOS: Estudio prospectivo, experimental, con asignación al azar, de casos y controles, longitudinal, comparativo efectuado durante el 2022, en el que se incluyeron pacientes con factores de riesgo de hemorragia posparto que finalizaron el embarazo mediante cesárea de urgencia. Se integraron dos grupos: experimental, en quienes se aplicó la técnica de ligadura bilateral de arterias uterinas y el grupo de control, solo con cesárea. Antes y después del procedimiento quirúrgico se estimaron la pérdida de sangre, los parámetros de hemoglobina y hematocrito y se compararon con el grupo de control.

RESULTADOS: Se estudiaron 91 pacientes: 45 en el grupo experimental y 46 de solo cesárea. Se observaron diferencias significativas en la pérdida de sangre del grupo

¹ Obstetrician-Gynecologist.

² Obstetrician-Gynecologist, chief of Obstetrics and Gynecology services.

³ Research Coordinator, Research and Education Department.

⁴ Health Sciences PhD, Associate Researcher at the Veterinarian and Zootechnics Medicine Faculty, Campus II. Autonomous University of Chiapas, and to the Education Department. Regional Hospital Dr. Rafael Pascacio Gamboa, Tuxtla Gutiérrez, Chiapas.

Received: October 2023

Accepted: November 2023

Correspondence

Sury Antonio López Cancino
sury.antonio@gmail.com

This article should be cited as: Nucamendi-Solis E, Chávez-Reyes JM, Long-Morales NJ, Hernández-Gamboa LE, López-Cancino SA. Prevention of postpartum hemorrhage among women at risk using uterine artery ligation technique during cesarean section. Ginecol Obstet Mex 2024; 92 (2): 50-56.



experimental (345.56 ± 64.69 mL) en comparación con el grupo control (426.06 ± 125.49 mL; $p = 0.000247$), en los parámetros de hemoglobina (grupo experimental: 11.13 ± 1.62 g/dL; grupo control: 10.49 ± 1.32 g/dL, $p = 0.037$) y hematocrito (grupo experimental: 33.86%; grupo control: 31.87%; $p = 0.017$).

CONCLUSIÓN: La ligadura bilateral de las arterias uterinas a pacientes con factores de riesgo de hemorragia poscesárea es una medida preventiva eficaz que ayuda a disminuir la pérdida sanguínea. Al complementarla con los uterotónicos reduce el volumen de sangrado.

PALABRAS CLAVE: Arteria uterina; factores de riesgo; hemorragia posparto; embarazo; hematocrito; hemoglobina.

BACKGROUND

According to the World Health Organization (WHO), nearly 70,000 women in the world lose their lives every year because of postpartum hemorrhage. It is the second cause of maternal death in the American continent.¹ Postpartum hemorrhage in Mexico was the first cause of maternal death, with 16.9% of deaths in 2022, for women between 28 and 35 years, while the state of Chiapas was fifth place of deaths by this cause.²

Postpartum hemorrhage is defined by the loss of 500 mL, or more, of blood during the 24 hours after delivery, and serious postpartum hemorrhage is the loss of 1000 mL of blood, considering blood volume and hemoglobin previous levels.^{3,4,5} Uterotonics are recommended to reduce the risk of blood loss (oxytocin, heat-stable carbetocin, misoprostol, ergometrine, among others), which have shown to reduce postpartum and post-surgery hemorrhage.⁶ Recent evidence suggests that the permanent ligation of the uterine, or ovarian arteries, is an important strategy to control postpartum hemorrhage, which in combination with other physical and pharmacological strategies, reduces bleeding significantly.⁶⁻⁹

Postpartum hemorrhage is a medical emergency, and as such, an adequate and immediate care represents the opportunity to reduce the risk of death. Uterine atony, lacerations, placenta previa, the anomalies in its insertion or retention, as well as disorders in coagulation times, are risk factors associated with bleeding.^{10,11,12} Additionally, a history of previous postpartum hemorrhage, obesity, high parity, Asian or Hispanic ethnicity, precipitous labor, uterine overdistension (multiple gestation, polyhydramnios, macrosomia), chorioamnionitis, uterine inversion, leiomyoma, Couvelaire uterus, hereditary bleeding diathesis, acquired bleeding diathesis (amniotic fluid embolism, *abruptio placentae*, sepsis, fetal death), assisted reproduction technology, and some medication, such as uterine relaxants, and antithrombotic agents, are also risk factors.¹³⁻¹⁶

Treatments for patients with postpartum hemorrhage include uterotonics, compressive physical devices, and conservative or definitive surgical procedures. Said interventions have shown to reduce bleeding to varying degrees.¹⁷⁻²³ Evidence related with the implementation of invasive surgical procedures to stop hemorrhage and preserve fertility, require the bilateral ligation of

the internal iliac artery, and of the uterine arteries as well, among others. The B-Lynch and Hayman techniques have shown their effectiveness.^{18,24-29} In Mexico, conservative surgical techniques, such as Posadas-Nava's, which are oriented to a selective ligation of the uterine arteries, entering by the rear face of the uterus, have been shown to be safe and effective for postpartum hemorrhage control.^{22,23} However, there is no history of the prophylactic implementation of the uterine arteries ligation in patients at risk of post-cesarean hemorrhage.

Due to the afore mentioned, the goal of the study was to evaluate the preventive benefits of the bilateral uterine artery ligation in patients at risk of postpartum hemorrhage, after C-section.

MATERIALS AND METHODS

Prospective, experimental, non-probabilistic, randomized, convenience, case-control, longitudinal, comparative study, where pregnant patients at risk of postpartum hemorrhage, near end of pregnancy, were included. The study was conducted between January 1, and December 31, 2022, at the Regional Hospital Dr. Rafael Pascasio Gamboa, in Tuxtla Gutiérrez, Chiapas. *Inclusion Criteria:* Patients aged 18 and older with C-section requirement, with one or more of the following risk factors: twin, or high order pregnancy, history of postpartum hemorrhage, fetal macrosomia, protracted labor, protracted expulsion stage, failed conduction of labor, multiparity, chorioamnionitis, or polyhydramnios. *Exclusion criteria:* Patients who didn't meet the inclusion criteria, or with hereditary or acquired coagulopathy, prepartum hemorrhage, placenta previa, or *abruptio* placenta. *Elimination criteria:* Patients who did not follow the study through. The experimental group was made up of patients who underwent prophylactic bilateral uterine artery ligation. The control group was made up of patients who didn't accept the prophylactic procedure, and only had their post-surgical

bleeding volume measured. Both groups voluntarily agreed to participate in the study with a written informed consent. The Research Ethics Committee of the Regional Hospital Dr. Rafael Pascasio Gamboa reviewed the protocol and authorized its execution. All the patients had a full blood count made to evaluate hemoglobin and hematocrit values.

The prophylactic application of the bilateral uterine artery ligation for the experimental group was made with the Posadas technique.²³ Upon the end of the surgery, the absence of bleeding was verified by intravaginal and suture exploration, confirming an effective procedure. The C-section in the control group was made with a classic uterine incision. In both groups, the procedures were made by the same surgical team.

The evaluation of bleeding for both groups was made by weighing the compresses used during the intervention, and 24 hours after the C-section. The determination of hematocrit and hemoglobin was made by a full blood count.

Studio variables: age, gestation weeks, obstetric and perinatal history, pregnancy term, postpartum hemorrhage risk factors, bleeding volume, uterotonics indication. Said information was gathered in an Excel spreadsheet for descriptive analysis, using the mean, as an approximation to normality measurement. To evaluate the statistical differences between the two groups, a t of Student test of two independent samples was used, with SPSS Statistics IBM® software, version 25.0, and values of $p < 0.5$ were considered significant.

RESULTS

Ninety-one patients were studied: 45 in the experimental group, and 46 in the C-section group. With average age of 28.5 ± 7.1 years, and 38 ± 2.71 gestation weeks, at the time of the intervention. Regarding obstetric history, 1% (n



= 1) had vaginal birth history, 52% (n = 47) had a previous C-section, and 47% (n = 47), both.

Significant differences were found in the experimental group's blood loss (345.56 ± 64.69 mL) in comparison with the control group (426 ± 125.49 mL; $p = 0.000247$), while hemoglobin was 11.13 ± 1.62 g/dL vs 10.49 ± 1.32 g/dL, $p = 0.037$, for experimental and control groups, respectively, and 33.86% vs 31.87%, $p = 0.017$, for hematocrit parameters in the experimental vs control groups.

The main probable causes for postpartum hemorrhage after C-section for both groups are shown in **Table 1**.¹⁰

The risk factors associated with post-cesarean hemorrhage were: multiparity 38% (n = 35), twin pregnancy 10% (n = 9), fetal macrosomia 10.9% (n = 11), protracted expulsion stage, identified as protracted labor 9% (n = 8), and failed conduction 3% (n = 3). Other factors found were: chorioamnionitis in 3% (n = 3), polyhydramnios 3% (n = 3), and hemorrhage history 2% (n = 2).

In the experimental group, 22 out of 45 patients had a history of multiple deliveries, with a range of 3 to 7 pregnancies. Of these patients, only 3 reported having previous abortions. In the control group, only 11 of the 46 had a history of multiple deliveries, with a range of 3 to 8.

Table 1. Main probable causes of postpartum hemorrhage in participants of both groups with C-section indication

Cause	%	Frequency
Multiparity	38	35
Macrosomia	11	11
Twin pregnancy	10	9
Protracted expulsion stage	9	8
Chorioamnionitis	3	3
Polyhydramnios	3	3
Failed conduction	3	3

In general, the average volume of bleeding during the surgical intervention was 386.26 ± 107.51 mL (CI 95.0%). Two out of 45 patients in the experimental group had blood loss of more than 500 mL (600 mL), and 14 out of 46 patients in the control group had blood loss between 500 and 800 mL. From these 14 patients, 11 received carbetocin, and 3 oxytocin, as an additional treatment to prevent postpartum hemorrhage.

Regarding the efficacy of the preventive application of bilateral uterine ligation, measured by the volume of bleeding, hemoglobin, and hematocrit values, the experimental group showed significant differences, in comparison to mean values of the control group. **Table 2.**

To prevent uterine atony, uterotonics of proven efficacy were used in both study groups, in equal proportions.

Bleeding greater than 500 mL was observed in patients with classic C-section, plus 100 mcg carbetocin (11 of 33 patients; $p = 0.0060$), in comparison with patients who only received 20 IU oxytocin (3 of 15 patients; $p = 0.0679$) (**Table 3**). Postsurgical atony (1 of 45) was the only complication observed in the experimental group. For the control group, besides postsurgical atony (4 of 46), the most frequent complications were a tear in the hysterorrhaphy commissure (2 of 46), and bladder injury (1 of 46).

DISCUSSION

For the present study, the bilateral uterine arteries ligation was prophylactically performed after C-section to a group of primigravida and multipregnancy patients who presented risk factors for postpartum hemorrhage. The preliminary outcomes point to an efficacy of the bilateral uterine arteries ligation, with a significant decrease in blood loss, and hematocrit and hemoglobin levels ($p < 0.05$). To our knowledge, there are no studies in Mexico about the application of a

Table 2. Blood loss values, hemoglobin and hematocrit pre- and post-surgical parameters

	Experimental group ($\bar{x}$ /SD)	Confidence interval (95%)	Control group ($\bar{x}$ /SD)	Confidence interval (95%)	P value
Bleeding (mL/DE)	345.56 / 64.69	19.43	426.09 / 125.49	37.27	0.000247
Hb (g/dL) Pre	11.93 / 1.34	0.4	11.93 / 1.32	0.39	0.937
Hb (g/dL) Pos	11.13 / 1.62	1.62	10.49 / 1.32	1.32	0.037
HTO (%) Pre	35.46 / 3.99	1.2	35.36 / 3.88	1.15	0.845
HTO (%) Pos	33.86 / 4.47	1.34	31.87 / 3.78	1.12	0.017

$\bar{x}$: average, SD: standard deviation, Hb: hemoglobin, HTO: hematocrit PRE: pre-surgical, POS: post-surgical.

Table 3. Use of uterotonic agents with patients in the study

Uterotonic	Experimental group (n = 45)		Control group (n = 46)		Chi ² (p value) CI 95%
	Frequency/ Proportion (%)	Bleeding >500m L	Frequency/ Proportion (%)	Bleeding >500m L	
Oxytocin	15/34	0/15	15/33	3/15	3.3 (0.0679)
Carbetocin	30/66	2/30	31/67	11/31	7.5 (0.0060)

surgical technique which involves an early ligation of uterine arteries as a preventive measure for postpartum hemorrhage in patients with risk factors to end pregnancy with a C-section.

While there are prophylactic procedures that use uterotonic agents, or other obstetric measures and strategies, the implementation of surgical techniques has shown to be efficacious at reducing significantly the average blood loss.²⁸ The bilateral uterine artery ligation has also been shown to significantly decrease bleeding in patients with similar characteristics to the sample of the present study, such as risk of uterine atony due to multiparity, twin pregnancy, macrosomia, polyhydramnios, iron deficiency, or chorioamnionitis.²⁹

The experimental group participants had lower average blood loss (345.56 ± 64.69 mL) in comparison to the control group (426.06 ± 125.49 mL; $p < 0.05$). Other studies have reported

similar outcomes, with blood loss volumes of 569.3 ± 202.1 mL in the experimental group, and 805.1 ± 224.5 mL in the control group ($p = 0.002$), after bilateral uterine artery ligation, before C-section in a group of women with *placenta previa*. Significant differences in hemoglobin and hematocrit values have also been reported, with values of $p < 0.05$, with 11.13 dL in the experimental group, and 10.49 dL in the control group, and 33.86% in the experimental group, and 31.87% in the control group, for hemoglobin and hematocrit, respectively.^{26,27} We found in the present study, that for patients at risk of postpartum hemorrhage, the bilateral uterine artery ligation reduced blood loss, maintained hemoglobin values, and slightly decreased the hematocrit percentage under the lower threshold (35.5%).

The results of the present study are compared to those previously published for Mexican women with uterine artery selective ligation, with poste-



rior access as a preventive measure, with success rates that range from 80 to 100%, outcomes which are reflected in a decrease of hemorrhage and complications.²² There were complications in the control group (commissure tear and bladder injury). In general, these complications are not life threatening for the mother, and none of the patients required blood transfusion, or hemoderivatives.

A highlight among the strengths of the present study, is being the first in Mexico to prophylactically do the bilateral uterine artery ligation with posterior access, in women with risk factors for postpartum hemorrhage, showing an important decrease in blood loss during, and after C-section. Also, we observed a heightened effect of the prophylactic uterine artery ligation in combination with uterotonics, to reduce post-surgical blood loss. Everything points to encouraging results upon the continuation of the present research. The limitations of the study were the sample size, and the lack of follow-up in the mid and long term of the participants.

CONCLUSION

The bilateral uterine artery ligation is an efficacious preventive measure to help reduce blood loss for patients at risk of post-C-section hemorrhage. In combination with uterotonics it reduces the bleeding volume.

REFERENCES

1. Organización Panamericana de la Salud-Organización Mundial de la Salud.
2. Cero muertes maternas por hemorragia. OPS-OMS 2023. <https://www.paho.org/es/cero-muertes-maternas-por-hemorragia>. Observatorio de Mortalidad Materna. OMM 2022. <https://omm.org.mx/sistema-de-indicadores/boletines/>
3. Recomendaciones de la OMS para la prevención y el tratamiento de la hemorragia posparto. Organización Mundial de la Salud. 2014. https://apps.who.int/iris/bitstream/handle/10665/141472/9789243548500_spa.pdf;jsessionid=394DBF24CE461B149A6B9E82CBB2C197?sequence=1
4. Schlembach D, Mörtl MG, Girard T, Arzt W, Beinder E, Brezinka C, et al. Management of postpartum hemorrhage (PPH) Algorithm of the interdisciplinary DA-CH consensus group PPH (Germany-Austria-Switzerland). *Anaesthesist* 2014; 63: 234-42. doi:10.1007/s00101-014-2291-1
5. Prevención y manejo de la hemorragia posparto. Guía de Práctica Clínica: Evidencias y Recomendaciones. México. Centro Nacional de Excelencia Tecnológica en Salud. CENETEC. 2021. <http://www.cenetecdifusion.com/CMGPC/GPC-SS-103-21/ER.pdf>
6. Lalonde A; International Federation of Gynecology and Obstetrics. Prevention and treatment of postpartum hemorrhage in low-resource settings. *Int J Gynaecol Obstet* 2012; 117 (2): 108-8. doi:10.1016/j.ijgo.2012.03.001
7. Rueda Monsabe A, Sanabria-Castelblanco JE, Montañez-Aldana MA. Manejo de la hemorragia posparto en una paciente con útero bicornue con la sutura B-Lynch. Reporte de caso y revisión de la literatura. *Revista Colombiana de Obstetricia y Ginecología* 2023; 74:2. doi:10.18597/rcog.3989
8. Butwick AJ, Carvalho B, Blumenfeld YJ, El-Sayed YY, Nelson LM, Bateman BT. Second-line uterotonics and the risk of hemorrhage-related morbidity. *Am J Obstet Gynecol* 2015; 212 (5): 642.e1-642.e6427. doi:10.1016/j.ajog.2015.01.008
9. Kuwabara M, Takahashi Y, Iwagaki S, et al. Effectiveness of preventive B-Lynch sutures in patients at a high risk of postpartum hemorrhage. *J Obstet Gynecol Research* 2022; (48): 12: 3111-3118. doi:10.1111/jog.15415
10. Wetta L A, Szychowski JM, Seals S, Mancuso MS, Biggio JR, & Tita AT. Risk factors for uterine atony/postpartum hemorrhage requiring treatment after vaginal delivery. *Am J Obstet Gynecol* 2013; 209 (1): 51.e1-51. e516. doi:10.1016/j.ajog.2013.03.011
11. Stones RW, Paterson CM, Saunders NJ. Risk factors for major obstetric haemorrhage. *Eur J Obstet Gynecol Reprod Biol* 1993; 48: 15-18. doi:10.1016/0028-2243(93)90047-g
12. Liu CN, Yu FB, Xu YZ, Li JS, Guan ZH, Sun MN, et al. Prevalence and risk factors of severe postpartum hemorrhage: a retrospective cohort study. *BMC Pregnancy and Childbirth* 2021; 21 (1): 332. doi:10.1186/s12884-021-03818-1
13. Say L, Chou D, Gemmill A, Tunçalp Ö, Moller AB, Daniels J, Gülmezoglu AM, Temmerman M, Alkema L. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health* 2014; 2 (6): e323-33. doi:10.1016/S2214-109X(14)70227-X
14. Oyelese Y, Ananth CV. Postpartum hemorrhage: epidemiology, risk factors, and causes. *Clin Obstet Gynecol* 2010; 53 (1): 147-56. doi:10.1097/GRF-
15. Al-Zirqi I, Vangen S, Forsen L, Stray-Pedersen B. Prevalence and risk factors of severe obstetric haemorrhage. *BJOG* 2008; 115 (10): 1265-72. doi:10.1111/j.1471-0528.2008.01859.x
16. Ende HB, Lozada MJ, Chestnut DJ, et al. Risk factors for atonic postpartum hemorrhage: a systematic review

- and meta-analysis. *Obstet Gynecol* 2021; 137: 305-23. doi:10.1097/AOG.0000000000004228
17. García-Espinosa M, Martínez-Torres JA, Caldiño-Soto F. Ligadura de arterias hipogástricas previo al alumbramiento o a la histerectomía obstétrica modificada en inserción anómala de placenta. *Ginecol Obstet Méx* 2022; 90 (11): 869-85. doi:10.24245/gom.v90i11.7910.
 18. Lynch BC, Coker A, Lawal AH, Abu J, et al. The B-Lynch surgical technique for the control of massive postpartum haemorrhage: an alternative to hysterectomy? Five cases reported. *BJOG* 1997; 104 (3): 372-75. doi:10.1111/j.1471-0528.1997.tb11471.x
 19. Elbourne DR, Prendiville WJ, Carroli G, Wood J, McDonald S. Prophylactic use of oxytocin in the third stage of labour. *Cochrane Database Syst Rev* 2001; (4): CD001808. doi:10.1002/14651858.CD001808
 20. McDonald S, Abbott JM, Higgins SP. Prophylactic ergometrine-oxytocin versus oxytocin for the third stage of labour. *Cochrane Database Syst Rev* 2004; (1): CD000201. doi:10.1002/14651858.CD000201.pub2
 21. Allam MS, B-Lynch C. The B-Lynch and other uterine compression suture techniques. *Int J Gynaecol Obstet* 2005; 89: 236-41. doi:10.1016/j.ijgo.2005.02.014
 22. Posadas-Nava A, Moreno-Santillán, Celis-González C, & Cruz-Martínez, E. Control de la hemorragia obstétrica mediante ligadura selectiva de las arterias uterinas. Experiencia de siete años. *Ginecol Obstet Mex* 2019; 87 (9): 576-82. doi: 10.24245/gom. v87i9.2946
 23. Posadas-Nava A, Moreno-Santillán AA, Celis-González C, et al. Control efectivo de la hemorragia obstétrica posparto mediante desarterialización selectiva uterina. Descripción de la técnica Posadas. *Ginecol Obstet Mex* 2016; 84 (12): 808-813. <https://ginecologiyobstetricia.org.mx/download/1183>
 24. Villegas-Arias MA, Toro-Ortiz JC, Hernández-Rodríguez HG, Fernández-Lara JA. Balón de Bakri en el control de la hemorragia obstétrica. Experiencia de cinco años. *Ginecol Obstet Mex* 2022; 90 (10): 809-18. doi:10.24245/gom.v90i10.3145.
 25. Refaie W, Fawzy M, Shabana A. Prophylactic bilateral internal iliac artery ligation for management of low-lying placenta accreta: a prospective study. *Tanta Med J* 2014; 42:146-50. doi:10.4103/1110-1415.145278
 26. Sanad AS, Mahran AE, Aboufotouh ME, et al. The effect of uterine artery ligation in patients with central placenta previa: A randomized controlled trial. *BMC Pregnancy Childbirth* 2018; 18: 351. doi:10.1186/s12884-018-1989-5.
 27. Abbas AM, Shady NW, Sallam HF. Bilateral uterine artery ligation plus intravenous tranexamic acid during cesarean delivery for placenta previa: a randomized double-blind controlled trial. *J Gynecol Obstet Hum Reprod* 2019; 48 (2): 115-19. doi: 10.1016/j.jogoh.2018.10.023
 28. Erin R, Issak A, Baki Erin K, Kulaksiz D, Bayoğlu TY. The efficiency of temporary uterine artery ligation on prevention of the bleeding in cesarean section. *Gynecologic and Obstetric Investigation* 2021; 86 (6): 486-93. doi:10.1159/000519370
 29. Ahmed S, Mohammed KA, Ahmed MA, et al. Randomized controlled trial of the effect of bilateral uterine artery ligation during cesarean among women at risk of uterine atony. *Int J Gynecol Obstet* 2020; 148: 219-24. doi:10.1002/ijgo.13064