

## Efficacy, Complications and Effects of Alcides Pereira's Sutures in the Management of Uterine Atony: A Retrospective Study

### Eficácia, Complicações e Impacto das Suturas de Alcides Pereira em Mulheres com Atonia Uterina: Um Estudo Retrospetivo

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#### ABSTRACT

**Introduction:** Uterine compressive sutures are conservative measures applied in cases of severe postpartum hemorrhage unresponsive to uterotonics. Pereira's suture was introduced in 2005 and consists of two longitudinal and three transverse non-transfixes sutures. Previous studies reported favorable results, highlighting its benefits and value. The aim of this study was to assess the efficacy, complications, and impact on fertility and future pregnancies of Pereira's suture applied in cases of uterine atony and postpartum hemorrhage.

**Methods:** An observational retrospective study was performed by consulting the medical records of women treated with Pereira's compressive sutures in a tertiary center between January 2013 and December 2022. We registered demographic data, pregnancy outcomes, short-term complications, and outcomes of subsequent pregnancies.

**Results:** A total of 50 women were treated with Pereira's suture. The overall success rate was 96% and no hysterectomies were performed. Women who had sutures performed during an intra-cesarean section had better outcomes than those who had an after-cesarean section. Complications were reported in 12% (n = 6) of women, with the most frequent being pelvic infection (n = 3) and abdominal pain (n = 3). Regarding fertility, all women desiring a future pregnancy (n = 5) were able to conceive, resulting in three live births.

**Conclusion:** Pereira's suture is a type of suture that provides numerous advantages and should be considered when first-line medical treatment fails. When applied at an early stage, the sutures may prevent maternal morbidity. The Alcides Pereira's suture is a safe technique and appears to preserve fertility.

**Keywords:** Postpartum Hemorrhage/surgery; Postpartum Period; Suture Techniques; Uterine Inertia

#### RESUMO

**Introdução:** As suturas uterinas compressivas são uma medida conservadora a adotar em casos de hemorragia pós-parto grave refratária a uterotónicos. As suturas de Alcides Pereira foram introduzidas em 2005 e consistem em duas suturas longitudinais e três suturas transversas não transfixivas. Estudos prévios revelaram resultados favoráveis, demonstrando o benefício e valor da técnica. O objetivo deste estudo foi avaliar a eficácia, complicações e impacto na fertilidade e futuras gravidezes em mulheres submetidas às suturas de Alcides Pereira em casos de hemorragia pós-parto por atonia uterina.

**Métodos:** Estudo observacional retrospectivo realizado através da consulta de processos clínicos de mulheres tratadas com suturas de Alcides Pereira num hospital terciário entre janeiro de 2013 e dezembro de 2022. Foram registados dados demográficos e desfechos relativos à gravidez, complicações a curto e longo prazo associadas às suturas e consequências na fertilidade e gravidezes futuras.

**Resultados:** Foram tratadas 50 mulheres com suturas de Alcides Pereira com resultados eficazes no controlo da hemorragia pós-parto em 96% dos casos, e não tendo sido realizada nenhuma histerectomia periparto. Verificaram-se melhores desfechos associados às situações nas quais as suturas foram aplicadas mais precocemente intracésariana versus relaparotomia. Em 12% (n = 6) das mulheres foram documentadas complicações: as mais frequentes foram a infeção pélvica (n = 3) e dor abdominal (n = 3). No que respeita a fertilidade, todas as mulheres que desejaram uma futura gravidez (n = 5) conseguiram conceber espontaneamente, tendo-se registado três nados vivos.

**Conclusão:** As suturas de Alcides Pereira são um tipo de sutura hemostática que confere múltiplas vantagens, e que deve ser considerada após a falha do tratamento médico na hemorragia pós-parto. Se aplicadas precocemente, poderão prevenir a morbilidade materna. As suturas de Alcides Pereira são seguras e associam-se a preservação da fertilidade.

**Palavras-chave:** Atonia Uterina; Hemorragia Pós-Parto; Período Pós-Parto; Técnicas de Sutura

#### INTRODUCTION

Postpartum hemorrhage (PPH) remains as the leading cause of maternal mortality world-wide, resulting in 70 000 maternal deaths each year globally,<sup>1</sup> and its rate has been increasing.<sup>2</sup> Uterine atony is the main cause of PPH accounting for 70% - 80% of the cases.<sup>2</sup> If medical treatment fails to control the hemorrhage, surgical alternatives such as compressive sutures, uterine embolization, and vessel ligation can be performed, although these involve a longer execution time, longer learning curve, greater blood loss, and higher risk of causing injury to adjacent structures.<sup>3</sup>

Peripartum hysterectomy is the last option since it is associated with greater morbidity and leads to infertility.<sup>2</sup>

In 2002, a unique type of compressive suture that would be further described in 2005, known as Alcides Pereira's suture, was performed in our institution for the first time.<sup>4</sup> This suture consists of a series of transverse and longitudinal sutures that are placed around the uterus and inserted superficially in the serous membrane and subserous myometrium without penetrating the uterine cavity. It starts with the superior transverse suture in the anterior side of the

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uterus, crossing the broad ligament towards the posterior side, then crossing the opposite broad ligament towards the anterior wall, and then tying the suture. Usually, two more transverse sutures are applied with the lowest used as an anchor to the knots of the two longitudinal sutures. The longitudinal sutures start on the dorsal side of the uterus and end on the ventral side. Given the great experience we have had so far, Pereira's suture has become the standard technique in our institution.

Until now, only small case series and cohort studies have been reported showing promising results.<sup>5-8</sup> There is still insufficient data regarding short- and long-term complications and their implications for fertility. We report the largest case series described so far of women treated with Pereira's suture, aiming to evaluate its efficacy, morbidity, and subsequent pregnancy outcomes after this hemostatic suture.

## METHODS

We performed an observational retrospective study in which we retrospectively reviewed the medical records of women who received Alcides Pereira's uterine compressive sutures at our institution, a tertiary medical center in Portugal, between January 2013 and December 2022 (Fig. 1).

To select the cases, we analyzed the clinical records of all women who received this treatment during the study period. To obtain additional information, patients were contacted by telephone.

We registered (1) demographic characteristics: age, ethnicity, parity, number of previous cesarian sections and

comorbidities; (2) data regarding pregnancy: mode of conception, simple and multiple pregnancies and pregnancy disorders; (3) delivery outcomes: gestational age at delivery time, induction of labor, elective or urgent cesarian delivery and its motive, indication to perform Pereira's suture, timing of suture use, whether intra or after cesarean section (CS), and in this case, the median time from the cesarean to re-laparotomy, efficacy and need for additional surgical procedures, administration of drugs and blood products, estimated blood loss, pre- and post-operative hemoglobin level, mother and newborn admission to intensive care, newborn weight and neonatal death; (4) short-term complications within one month after sutures: abdominal pain, fever and sepsis, hematometra and pyometra vaginal blood loss and purulent discharge; (5) fertility outcomes: desire for pregnancy, diagnosis of pregnancy, age and time until conception; mode of conception; pregnancy outcomes; mode of delivery and complications during labor.

In our center, according to our protocol, we performed Pereira's suture when facing a PPH due to atony that was not responsive to uterine massage and medical treatment, which includes oxytocin, rectal prostaglandin E1, sulprostone perfusion and/or direct intra-myometrial injection (doses are expressed on Table 1). If such interventions fail, we can progress to uterine tamponade or hemostatic sutures – the timing to do so depends on the surgeon's criteria. Ultimately, arterial ligation, uterine embolization, or hysterectomy are performed. In our study, we defined efficacy of Pereira's suture if bleeding stopped after its use without the need of additional measures. Pereira's suture was also

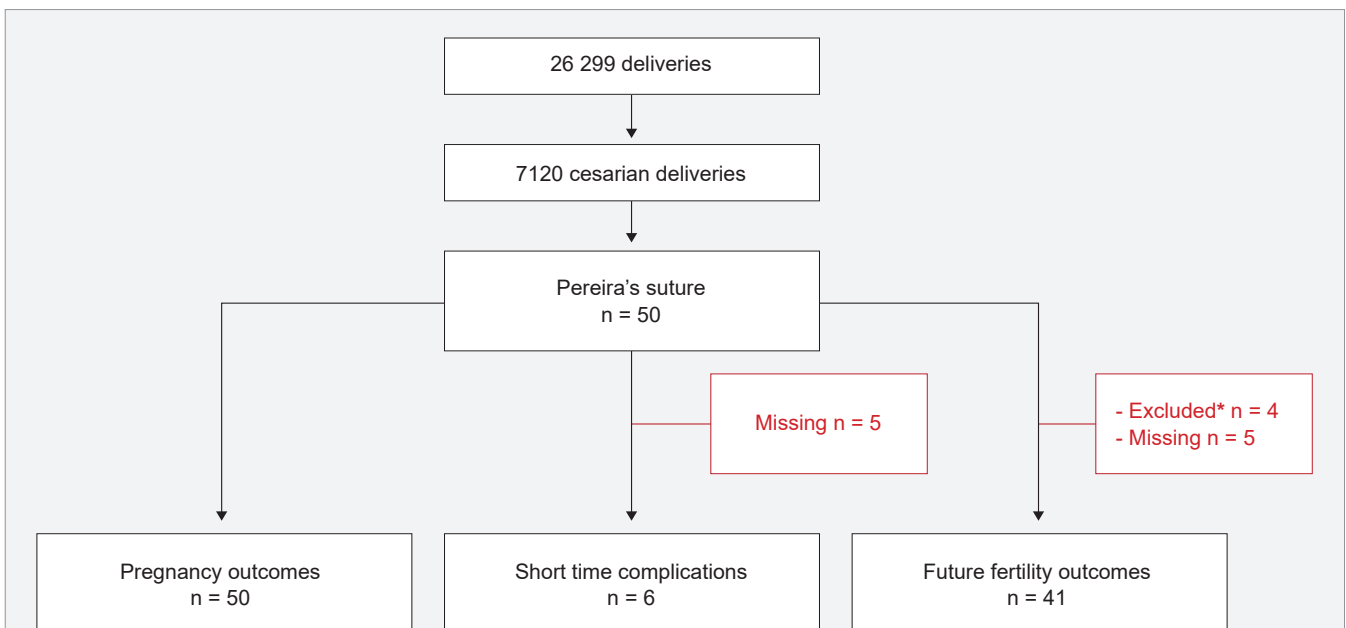


Figure 1 – Methodology of the observational study

\* Four women excluded due to sterilization procedure

applied in other conditions, such as isolated atony without massive hemorrhage and uterine inversion as a preventive measure, and placenta *accreta* spectrum disorders and placental abruption if uncontrolled bleeding occurred.

Regarding specific outcomes, such as complications and future fertility, we could not obtain information from all women. We consider these as missing cases and therefore were not included in the study of these variables. We excluded four women from future fertility outcomes since they had a sterilization procedure done.

Statistical analysis was performed with IBM® SPSS® Statistics 20.0. Continuous variables were summarized by median, minimum and maximum. Categorical variables were analyzed using absolute and relative frequencies. The 95% confidence interval associated with the efficacy of Pereira's suture was estimated using the exact Clopper-Pearson method. This study was approved by the ethics committee of our hospital. Informed consent was not necessary as this was a retrospective and anonymous study and all data considering patients are anonymous and protected.

## RESULTS

Over a period of ten years, there were 26 299 deliveries; of these, 7120 were cesarean deliveries. A total of 50 (0.7%) women were treated with Pereira's suture, and half of these cases were performed in the last three years of

the study. Table 1 shows the demographic characteristics of the study population. The median age was 34.5 years, and the most prevalent morbidity factor was obesity, present in 9 (18%) women. There were 12 (24%) women with at least one previous cesarean section and 10 (20%) multiple pregnancies. There were no grand multiparous women ( $\geq 5$  births). Regarding obstetric and pregnancy characteristics (Table 2), most deliveries (70%) were at term and the median gestational age was 38 weeks. During pregnancy, there were three cases of pre-eclampsia, two cases of HELLP syndrome, nine cases of chorioamnionitis, three cases of hydramnios, three cases of placenta *previa*, three cases of suspicion of placenta *accreta* spectrum and one case of hemolytic uremic syndrome.

Pereira's suture was efficient in 96%, CI 95% [86.3% - 99.5%], of the cases ( $n = 48$ ), controlling the PPH and atony with success. In the two unsuccessful cases, additional measures were necessary: both patients had placenta *previa*, one of them with *accretism*, in which uterine and hypogastric ligation were needed, respectively. There were no hysterectomies performed. Uterine atony ( $n = 36$ , 72%) was the most common cause of PPH, followed by placental abruption ( $n = 5$ , 10%). In three cases, Pereira's suture followed an ineffective use of balloon tamponade.

The exact timing of the performed sutures is not known as this is a retrospective study, and that information was not previously recorded. Table 1 expresses the uterotonic agents used before or during the suturing procedure. All women received oxytocin and the majority also received either prostaglandin E1 or sulprostone infusion. In some cases, the surgeons decided to deviate from the protocol and apply the sutures, citing their clinical judgment and considering an early-stage suturing to prevent morbidity.

In 12 (24%) cases, Pereira's suture was performed after cesarean delivery, with a median time of 5.5 hours between the cesarean section and relaparotomy. The median estimated blood loss was 1500 mL (maximum 3100 mL), and the median pre- and post-operative hemoglobin was 12.0 and 9.4 g/dL, respectively. The median hemoglobin variation was 2.5 g/dL and the maximum estimate of variation registered was 6.7 g/dL (please note that this variation might not represent the real values because they might not reflect the acute losses, and many women received red blood cells intra-operatively). A total of 21 (42%) patients received a red blood cell transfusion and 7 (14%) patients were admitted to the Intensive Care Unit. No maternal deaths occurred.

When comparing women who had sutures performed intra-cesarean section and after cesarean section (Table 3), the results showed that the second group had higher hemoglobin variation (2.0 vs 3.5 g/dL), higher estimated blood loss (1400 vs 2500 mL), higher need for red blood cells (26.3% vs 91.7%) and other blood products (7.9% vs 75%).

Table 1 – Baseline characteristics of the study population

Characteristic*	n = 50
Age, years	34.5 (18 - 47)
<b>Ethnicity, n (%)</b>	
Asian	2 (4)
Black	10 (20)
Mixed	8 (16)
White	30 (60)
<b>Parity, n (%)</b>	
Nulliparous	30 (60)
Multiparous	20 (40)
<b>Previous CS, n (%)</b>	
0	38 (76)
$\geq 1$	12 (24)
<b>Type of Pregnancy, n (%)</b>	
Simple	40 (80)
Twins	10 (20)
<b>Type of Conception, n (%)</b>	
Natural	45 (90)
ART	5 (10)

ART: assisted reproductive technology; CS: cesarean section.

\* Numeric variables are expressed in median, minimum and maximum; categorical variables are expressed in absolute and relative frequencies

Table 2 – Pregnancy characteristics and intraoperative findings

Characteristic*	n = 50
<b>Gestational age at delivery, years</b>	38 (23 - 41)
≥ 37 weeks, n (%)	35 (70)
34 - 36 weeks, n (%)	5 (10)
≤ 33 weeks, n (%)	10 (20)
<b>Induction of Labor, n (%)</b>	19 (38)
<b>Timing of CS, n (%)</b>	
Elective	17 (34)
Urgent/Emergent	33 (66)
<b>Birth weight, grams</b>	2748 (766 - 4244)
<b>Fetal death, n (%)</b>	1 (2)
<b>Neonatal NICU admission, n (%)</b>	5 (20)
<b>Chorioamnionitis, n (%)</b>	9 (18)
<b>Indication for PS, n (%)</b>	
Uterine atony	36 (72)
Placenta abruption	5 (10)
Placenta previa	2 (4)
Placenta previa and PAS	3 (6)
PAS	2 (4)
Uterine Inversion	2 (4)
<b>Moment of PS</b>	
Intra CS, n (%)	38 (76)
Post CS, n (%)	12 (24)
Time between CS and re-laparotomy, hours	5.5 (1 - 12)
<b>Uterotonic Agents<sup>a</sup>, n (%)</b>	
Oxytocin perfusion	50 (100)
Prostaglandin E1	30 (60)
Sulprostone perfusion	35 (70)
Sulprostone myometrial injection	13 (26)
<b>Use of other hemostatic procedure<sup>b</sup>, n (%)</b>	2 (4)
<b>Transfusion, n (%), median (min-max)<sup>c</sup></b>	
Red blood cells units	21 (42), 2.0 (1 - 14)
Fresh frozen plasma units	10 (20), 2.0 (1 - 8)
Platelet concentrations units	9 (18), 45.0 (1 - 12)
Fibrinogen, g	30 (60), 2.0 (1 - 6)
<b>Tranexamic acid, n (%)</b>	32 (64)
<b>Intravenous Iron infusion, n (%)</b>	21 (42)
<b>Blood loss</b>	
Estimated blood loss, mL	1500 (500 - 3100)
Pre-operative Hb, g/dL	12.0 (6.8 - 13.3)
Post-operative Hb, g/dL	9.4 (5.1 - 13.1)
Hb variation, g/dL	2.5 (0.3 - 2.7)
<b>Maternal ICU admission, n (%)</b>	7 (14)
<b>Maternal death, n (%)</b>	0 (0)

a) Doses: Oxytocin perfusion - 20 units/500 cc Ringer Lactate 250 ml/hour; Prostaglandin E1-800 µg sublingual/rectal; Sulprostone perfusion- 1 mg/500 cc saline solution 125 ml/hour; Sulprostone myometrial injection- 0.25 mg in each uterine *cornua* every 10 min up to 3 doses.

b) One case of uterine artery ligation and one of hypogastric artery ligation.

c) n (%) expresses number of women who received blood products; median (min-max) refers to the number of units transfused.

\* Numeric variables are expressed in median, minimum and maximum; categorical variables are expressed in absolute and relative frequencies

NICU: neonatal intensive care unit; PS: Pereira's suture; PAS: placenta *accreta* spectrum; Hb: hemoglobin; ICU: intensive care unit; Max: maximum; Min: minimum

The median number of red blood cell unit transfusion was 2.0 vs 5.0, respectively. The proportion of cases admitted to the Intensive Care Unit was also higher in the second group (5.3% vs 41.7%).

Post-operative complications were reported in six (12%) women. There were two cases of puerperal endometritis, one of them associated with placenta *accreta* with placenta left *in situ*. One patient presented with pelvic pain and purulent vaginal discharge. She was diagnosed with pyosalpinx and treated with antibiotics, although she maintains chronic pain. No cases of sepsis were registered. Two other patients reported abdominal pain that resolved after one and three months, respectively.

The impact on reproductive outcomes was examined (Table 4). We managed to follow up 45 women, and excluded the ones who had a sterilization procedure done (n = 4). Of a total of 41 women, there were five (12.2%) who expressed desire for future pregnancies. All of those women were able to conceive and three (60%) live births occurred. All pregnancies occurred after natural conception. The median age at conception was 37.0 years and the median time from suture procedure to conception was 4.0 years. There was one first trimester loss, one septic abortion at 14 weeks and one medical termination after a diagnosis of trisomy 21. One pregnancy was terminated at 35 weeks due to fetal

growth restriction while the other two were uneventful and reached full term. The mode of delivery was cesarean birth in all three cases, one of them due to previous Pereira's suture, the other two due to failure of induction of labor and growth restriction, respectively. In one case, extensive adhesions were noticed in the posterior aspect of the uterus and in another there was uterine atony that responded to medical treatment. No other complications were registered.

## DISCUSSION

Compressive sutures were first documented by B-Lynch *et al* in 1997, who described a novel technique to treat PPH in a conservative way, therefore avoiding hysterectomy.<sup>9</sup> Since then, numerous authors reported different modifications of compressive sutures that include variations of longitudinal, transverse and square sutures.<sup>10,11</sup> Despite comparative studies having already been conducted regarding different types of compressive sutures, no specific suture has been proven to be clearly superior to others.<sup>2,12,13</sup> The choice of suture should be individualized, as some might be more suitable for specific situations<sup>14</sup> and according to the experience of the surgeon. These techniques appear to be safe and effective,<sup>2,15</sup> consume less time and resources and are less complex than arterial ligation and embolization.<sup>16</sup>

Table 3 – Comparison between women who receive PS intra-CS versus PS after CS

Characteristic*	Intra- CS n = 38	Post- CS n = 12
Need for arterial ligation, n (%)	-	2 (16.7)
Estimated blood loss, mL	1500 (500 - 2500)	2500 (1000 - 3000)
Hb variation, gr/dL	2.0 (0.3 - 4.1)	3.5 (0.7 - 6.1)
Women receiving red blood cells units, n (%)	10 (26.3)	11 (91.7)
Women receiving other blood products, n (%)	3 (7.9)	9 (75)
Red blood cells transfusion, units	2.0 (0 - 3)	5.0 (1 - 14)
ICU admission, n (%)	2 (5.3)	5 (41.7)

Hb: hemoglobin; ICU: intensive care unit

\* Numeric variables are expressed in median, minimum and maximum; categorical variables are expressed in absolute and relative frequencies.

Table 4 – Reproductive outcomes

Case	Mode of conception	Time until conception (years)	Outcome	Mode of delivery/ Gestational age (weeks)	Complication during delivery	Birth weight (grams)
1	Natural	4	Uneventful	CS/41	None	3915
2	Natural	5	Pre-term birth, FGR	CS/ 35	Adhesions	1830
3	Natural	6	Spontaneous abortion	NA/8	NA	NA
4	Natural	1.5	Septic abortion	NA/14	NA	NA
5	Natural	2	Uneventful	CS <sup>a</sup> /39	Uterine atony	3302
6	Natural	1.5	Medical termination (trisomy 21)	NA/15	NA	NA

CS: cesarean section; FGR: fetal growth restriction; NA: non applicable

Case 4 and 5 concern the same women.

a) Due to previous uterine sutures



The overall effectiveness of uterine compressive sutures appears to be between 60% to 91.7%.<sup>12,16-19</sup> In our case series, we had a high efficacy rate of 96%, CI 95% [86.3% - 99.5%], with Alcides Pereira's sutures, reverting 48 of 50 cases of uterine atony without the need of hysterectomy. In cases related to abnormal placentation, Pereira's suture was successful in 5 of 7 (71.4%), therefore proving to be equally effective when facing these disorders, as it was described in previous studies.<sup>6</sup> We believe that the success of this technique relies on the fact that the multiple small bites of the uterus distribute the pressure evenly, resulting in more efficient compression.<sup>4</sup>

We found that women who had a delay between the delivery and uterine compressive sutures compared to intra-cesarean sutures had significantly higher morbidity, presenting with higher blood loss, higher decrease in hemoglobin levels, higher need for blood transfusion and other blood products and higher likelihood of admission to the ICU. This suggests that an earlier recognition and diagnosis of atony unresponsive to medical treatment and a faster intervention may decrease maternal morbidity. We estimate that the technique takes around five to 10 minutes to perform, depending on the surgeon's experience. We consider it a simple technique that can be performed by less experienced surgeons, has a shallow learning curve, and requires very few resources (*Vicryl 1*<sup>®</sup> and a 33-mm-sized needle).

Complications associated with compressive sutures are rare,<sup>13</sup> with the most frequent being acute and chronic endometritis.<sup>12,18,20,21</sup> Other complications include pyometra, possibly due to obliteration of cervical lumen,<sup>12,22</sup> uterine distortion,<sup>23-25</sup> uterine ischemia and necrosis,<sup>12,15,26-30</sup> uterine *synechiae*<sup>20</sup> and changes of menstrual flow.<sup>26,31</sup> Pereira's suture was the first and one of the few techniques that does not cross uterine walls and penetrate into the uterine cavity, therefore decreasing the risk of infection, pyometra, *synechiae* and, theoretically, infertility. The small bites avoid the risk of visceral entrapment with puerperal uterine involution and prevent the application of excessive focal pressure and, consequently, wall defects and uterine necrosis. Our results demonstrate that Pereira's suture is associated with few complications, that are, overall, non-severe. The most prevalent complication was infection (n = 3) and abdominal pain (n = 3).

A significant long-term concern is whether compressive sutures interfere with the reproductive future. The available data is insufficient, but the majority of the cases reported no serious complications in future pregnancies and no higher sterility rates.<sup>12,13,23</sup> A systematic review reported few adverse effects on fertility outcomes, with more than 85% of women desiring subsequent pregnancies being able to conceive.<sup>16</sup> Two retrospective cohort studies reported simi-

lar adverse pregnancy outcomes between women who received sutures from those who did not, except for a higher proportion of adhesions.<sup>23,32</sup> Our results are limited by the small number of women desiring to conceive (5/41), which can be understood since half of the cases occurred in the three previous years and most women did not wish a future pregnancy after an event that they considered traumatic. Even so, the fertility potential appears to have been preserved since all five women desiring pregnancy were able to conceive, with a 60% live birth rate. Our cases of subsequent pregnancies were all delivered by cesarean section, as most cases reported,<sup>12,15,24,32</sup> although two out of three were due to obstetrical reasons. In contrast with previous studies,<sup>33,34</sup> we believe that the use of a previous Pereira's suture should not be a formal indication of a CS since no additional incisions in the uterus are performed. As previously admitted, the risk of uterine rupture should not be higher than a CS, and there are several cases of vaginal delivery after uterine sutures.<sup>12,23</sup> Nevertheless, there should be a low threshold for a CS during delivery since there have been a few case reports of uterine rupture after B-Lynch suture.<sup>35-37</sup>

Only one of our patients received a post-op follow-up regarding assessment of the cavity. Having said that, a gynecological ultrasound and hysteroscopy should be considered three to four months after the application of the sutures to investigate any possible anatomical changes and as a pre-conception evaluation.<sup>33,38</sup>

The overall efficacy of Pereira's sutures presented in this study is notably high compared with the rates presented in the literature for other series. The authors believe that several factors contribute to this result: the unique characteristics of the technique, as mentioned above, the fact that these sutures were developed in our institution, where we have now been using them for nearly 20 years, giving us extensive familiarity and experience. Additionally, we occasionally implement them at an early stage, which could enhance the success rate. We recommend regular training of medical teams during the management of postpartum hemorrhage and suture application to further improve the success rate.

Our study presents some limitations such as the retrospective study design, the small sample size, especially regarding subsequent pregnancies, and the lack of a control group, which hinders the possibility of conducting a comparative analysis. The fact that there were no registered cases of Pereira's suture after vaginal deliveries makes it difficult to extrapolate our results in these cases. Finally, we consider the follow-up not long enough to assess long term complications and fertility outcomes since many cases are recent.

## CONCLUSION

This is, to the best of our knowledge, the largest case series related to Pereira's suture ever presented. Pereira's sutures are an effective uterus-preserving procedure that has proven to be a valuable measure when facing postpartum hemorrhage. An earlier recognition of atony and a faster intervention may decrease maternal morbidity. Fertility potential appears to be preserved. More studies are needed to make recommendations regarding post-operative surveillance after the sutures and during a subsequent pregnancy.

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## AUTHOR CONTRIBUTIONS

BF: Study design, data collection and analysis, drafting.

PN, JF: Study design, data collection.

IG, AP: Study design.

All authors approved the final version to be published.

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## PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

## DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

## PATIENT CONSENT

Obtained.

## COMPETING INTERESTS

The authors have declared that no competing interests exist.

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