



## Uterine atony: Current trends in invasive treatment

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World Journal of Advanced Pharmaceutical and Life Sciences, 2022, 02(02), 063–071

Publication history: Received on 18 April 2022; revised on 27 May 2022; accepted on 29 May 2022

Article DOI: <https://doi.org/10.53346/wjapls.2022.2.2.0027>

### Abstract

Uterine atony is the leading cause of postpartum hemorrhage. The etiological mechanism has not been fully clarified. Various predisposing risk factors either pre-existing in pregnancy or appearing during pregnancy have been blamed to date for causing postpartum hemorrhage and uterine atony. The diagnosis of uterine atony is clinical. The diagnosis presupposes the confirmed emptying of the endometrial cavity and the exclusion of traumatic etiology bleeding from the genital system. The multidisciplinary treatment after the early recognition of bleeding it is useful to focus on achieving satisfactory uterine contraction with administration matrix contraceptives (oxytocin, ergometrin alkaloids, prostaglandin, carbetocin) and in maintaining its hemodynamic stability with the use of preservatives (massages, double compression of the uterus) and surgical techniques. The tamponade balloon Bakri, the package from gauzes, several types of hemostatic sutures, ligation of internal iliac arteries, uterine arteries embolism and obstetric hysterectomy are older and newer techniques included in the modern invasive treatment of uterine atony. In this article based on recent bibliography is attempted a review of this obstetric complication, regarding its basic principles of invasive treatment, the timely and correct application of which can yield the best possible result and ensure the best health of mother.

**Keywords:** Uterine Atony; Bakri Balloon; Package Of Gauzes; Hemostatic Sutures; Ligation Of Internal Iliac Arteries; Embolism; Hysterectomy

### 1. Introduction

Postpartum blood loss in less than 500 ml is a normal process. Normally, blood loss is heavier immediately after vaginal delivery, gradually decreasing and continuing to decrease for up to six weeks at which time it has to stop. Postpartum hemorrhage is defined as blood loss equal to or greater than 500 ml within the first 24 hours after placenta delivery [1]. The postpartum hemorrhage accounts for about 6 to 10 % of all pregnancies with severe form (blood loss > 1000 ml) are estimated to be approximately 1.8% - 3% after any form of childbirth and varies by region in the world [2]. Postpartum hemorrhage is one of the leading causes of maternal death and severe maternal morbidity worldwide [3,4]. It is estimated today that it is the primary cause of maternal mortality, both in developing and in developed countries [5] and accounts for about 20% of maternal deaths worldwide [6].

The treatment of postpartum hemorrhage should be immediate. It is important for the structure of the health system to be functional in order to allow effective management of the situation [7]. Although the majority in some cases of blood loss is minor and not a cause for concern, in some cases the blood loss can be severe and can even be life-threatening for the woman. In any case the obstetrician, despite the difficulties, must be able to estimate the amount of blood lost

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after delivery and treat the situation according to its severity [8]. In any case it is also very important to be able to recognize the cause of bleeding, so that his intervention can be immediate and effective [9]. The most usual cause of postpartum hemorrhage is the inability of the uterus to contract immediately after placenta delivery ( uterine atony ) followed by traumatic etiology bleeding from the uterus, cervix or vagina, the stay of part of the placenta within the intrauterine cavity and blood coagulation disorders [10,11].

## 2. Uterine atony

Uterine atony is the pathological situation in which myometrium, after placenta delivery is unable to continue its stable contractile function, as a result the incomplete closure of the vessels in the area of placental halo and sometimes causing another degree of bleeding. Uterine atony is the main cause of postpartum hemorrhage and the most common cause of obstetric shock [12]. In recent years frequency of postpartum hemorrhage in developed countries is constantly increasing [13,14,15]. It is estimated that in the U.S.A the total rate of postpartum hemorrhage increased by about 26%: from 2,3% which was in 1994, in 2006 is estimated to have increased to 2,9% [16]. The uterine atony accounts for up to 80% of postpartum hemorrhages [17,18]. In contrast with other causes of obstetric bleeding, such as placenta abnormalities that may to be prenatally, uterine atony is difficult to predict [19].

## 3. Therapeutic approach

The inability to reliably predict pregnant women at high risk for obstetric bleeding leads to the view today that all pregnant women should be considered sensitive and extreme vigilance should be exercised when assessing blood loss and the hemodynamic stability in the immediate period of labor [20]. Early recognition of blood loss, identification of the source of bleeding and its rejuvenation including red blood cells and blood products when required is estimated to lead to excellent results [21]. Immediately after the recognition of bleeding, the treatment of which must be multidisciplinary and requires the cooperation of many medical specialities is useful to focus on achieving adequate uterine contraction with administration in contraceptives and in maintaining its hemodynamic stability using preservative non pharmaceutical mechanical or surgical means interventions [22,23,24], as shown in Table 1.

**Table 1** Therapeutic options for invasive approach to uterine atony

Bakriballontamponade
Uterine tamponade with gauze packaging
Hemostatic sutures of uterine compression
Ligation of internal iliac arteries
Uterine artery embolism
Obstetric hysterectomy

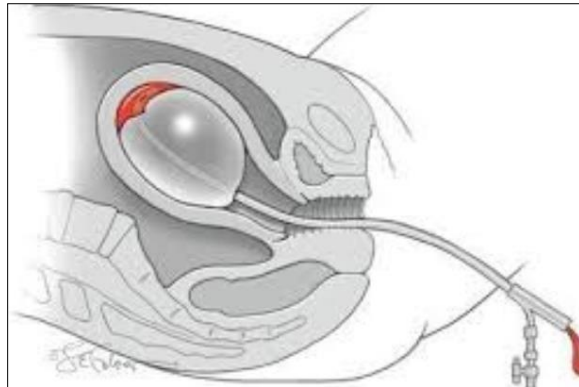
## 4. Surgery treatment

### 4.1. Uterine tamponade - Balloon Bakri

Intrauterine tamponade techniques to manage postpartum hemorrhage and uterine atony have been reported since 1856 [25]. The cotton gauze that has been used time to time due to increased risk wound the wall of the uterus that may be caused during placement, due to increased risk of intrauterine infection and increased risk of ineffectiveness of maternal contraceptives in developed economically independent countries are almost abandoned, giving way to the uterine tamponade balloon [26, 27]. The tamponade Bakri balloon is recommended by American College of Obstetricians and Gynecologists (ACOG) and the World Health Organization (WHO) as guideline for the treatment of postpartum hemorrhage and uterine atony that does not respond to uterine contraceptives [28]. The balloon Bakri made of silicone at the entrance adapts precisely to the intrauterine cavity. The balloon is gradually filled with liquid until it stops bleeding (Figure 1), achieving endometrial formation pressure which is greater than systemic blood pressure [29, 30].

Many studies to date have been designed to assess safety and effectiveness of the method in controlling postpartum hemorrhage. In 2014 Wright and his colleagues analyzing the results of their study, its purpose to verify the indications, techniques and morbidity associated with use of Bakri balloon showed that in cases of uterine atony its displacement

balloon was found in 10% of cases, blood transfusion needed in 43%, while obstetric hysterectomy was required in 6% of patients [31]. Most recently in 2017, Lo and his colleagues with their own study, the purpose of which was its evaluation of uterine capping with a Bakri balloon in cases of uterine atony showed that its use Bakri balloon is associated with reduced rates of obstetric hysterectomy [32].



**Figure 1** Bakri balloon tamponade correctly placed in intrauterine cavity for the management of bleeding after uterine atony

A similar, recent study from China showed that its early diagnosis of bleeding, combined with the early use of Bakri balloon is more effective in the management of bleeding [33]. On the contrary, Said Ali and his associates point out that the Bakri balloon seems to be one less effective means of treating postpartum hemorrhage, either originating after vaginal delivery or after cesarean section [28]. Nevertheless, has been described in bibliography successful management of postpartum hemorrhage with appropriate placement of a Bakri balloon in the bicornuate uterus [34].

#### 4.2. Uterine tamponade with gauze packaging

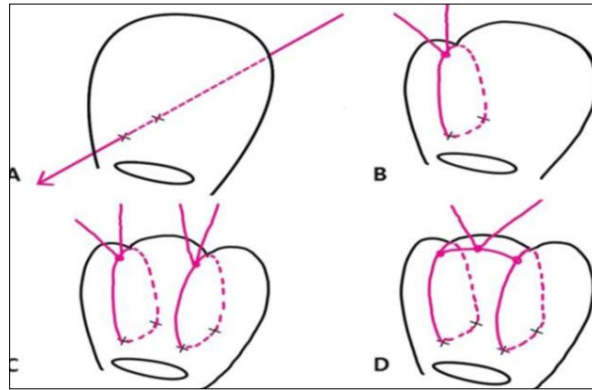
The tamponade of the uterus with packaging with gauze to treat postpartum hemorrhage is a common practice that has been used for decades and is still used in countries with limited health and care resources [35, 36]. Knowledge for gauze packaging in the intrauterine cavity is important because the time available in most cases is limited. The 8 to 10 meter long gauze package with the help of forceps or by hand is placed in the intrauterine cavity from the bottom up to the cervix and followed by tamponade the vagina in order to achieve additional pressure in the intrauterine cavity to ensure better hemostasis. The package is removed 12-24 hours after installation [37]. Today the tamponade of the uterus with gauze packaging, despite the insufficient analytical studies, is recommended in some guidelines [38, 39] and used widely in both rich and poor areas of China [40]. In a 2010 study by Wei and his colleagues, after its comparative evaluation efficacy and safety balloon uterine tamponade and gauze package to treat bleeding after cesarean section found that there was not statistically significant different in its successful treatment bleeding between patients treated with a capping balloon and in those which with gauze packaging was used (93.1% vs 91.2%,  $p=0.80$ ). At the same time the authors showed that the women of her cover group uterine tamponade balloon had significantly fewer side effects such as anemia, fever, postoperative pain, concluding that uterine tamponade with gauze is just as effective as using an intrauterine balloon for treatment of postpartum hemorrhage, but which should be the preferred alternative to minimize maternal morbidity [41]. Similarly Dueckelmann and his colleagues showed that gauze packaging chitosan coated is an excellent choice for treating postpartum hemorrhage, similar in effect to the uterine tamponade balloon [42].

#### 4.3. Hemostatic Sutures

In recent years, many pregnant women with bleeding after cesarean section were successfully treated by application of hemostatic sutures in the anterior and posterior wall of the uterus resulting in compression of the endometrial cavity - "compression sutures". The most popular technique is "B - Lynch suture" described in 1997 by B - Lynch at el of. It refers to a technique of suturing the uterus (Figure 3) which is indicated in treatment of uterine atony after cesarean section, as well as in cases high risk for intraoperative bleeding, such as chorioamnionitis, preeclampsia, multiple pregnancy and cesarean section after prolonged and laborious effect to achieve vaginal delivery [43,44].

Bibliographic data to date suggest that the B - Lynch suture may be an effective method of treating uterine atony before the decision to perform obstetric hysterectomy. In 2016 Kaya and partners during the research effort comparative evaluation of between B - Lynch compressive suture and the balloon Bakri plug to treat the uterine atony during

cesarean section showed the success rates of the two methods are similar (79.1% and 80% respectively). On the advantages of B - Lynch suture includes rapid application without requiring the patient to be stoned and low cost, but having the disadvantage that compared the Bakri balloon it is a more invasive and more difficult to learn method which should be a first line treatment option for its treatment uterine atony during cesarean section in developing countries lacking increased healthcare resources [45].



**Figure 2** Lynch suture placement for postoperative bleeding delivery: (A) Straight needle passes from the front to the back wall uterus at a distance of 2 - 3 cm above the cross - section of the cesarean section (B) The suture is tied tightly at about the height of the bottom of the uterus (C) The same process is repeated on the opposite side (D) At the top of the matrix the two stitches are tied together in the middle line to prevent slipping [43]

Most recently in 2018, Sahin and his associates analyzing its results study, the purpose of which was to evaluate the effectiveness of placement of double B - Lynch suture for the treatment of severe bleeding during cesarean section showed that the modified technique with application double suture seems to be an effective and reliable solution for treatment of uterine atony, while providing the preservation advantage fertility and achieving future pregnancy [46]. In an earlier study, El - Sokkary and his colleagues attempted to assess effectiveness of the new modified technique in controlling postoperative bleeding from uterine atony showed that the modified new technique seems to be more effective than classical technique, with a success rate of 95% versus 85% [47].

Similarly, Kaya and his colleagues from their own research experience, in order to evaluate the effectiveness and complications of the suture B - Lynch compression in cases of uterine atony not responding to conservative treatment showed that the suture success rate was 75%, while efficiency of the method combined with bilateral internal ligation iliac arteries amounted to 94.4%. The authors concluded that combined method did not increase the risk of short - term complications, such as necrosis of the uterus, while in case of failure of the B - Lynch compression suture the bilateral ligation of the internal iliac arteries may be an alternative to treating and maintaining bleeding female fertility [48].

#### 4.4. Ligation of Iliac Arteries

Ligation of the internal iliac arteries is an additional surgical option for treatment of uterine atony and postpartum hemorrhage with maintaining a woman's reproductive capacity. Ligation of the inner pelvis arteries was first performed by Sir Kelly in 1893 for severe control bleeding during a hysterectomy in a woman with advanced cancer uterus [49]. Later in 1960, ligation of the internal iliac arteries was introduced for the first time to control postpartum hemorrhage, and since was widely used in the control of severe pelvic bleeding in women who underwent gynecological and obstetric surgeries [50]. Today, the ligation of internal iliac arteries is rarely applied, mainly due to lack of adequate training, possible difficulties in surgical access and limited effectiveness in the treatment of bleeding after uterine atony [51]. Nevertheless, ligation of the internal iliac arteries should be considered the first treatment line in severe cases of postpartum hemorrhage, with variable but success rate ranging from 40% to 100% [52].

Recently in 2017, Kaya and his associates evaluating success rates and the subsequent fertility results after ligation internal iliac arteries to control bleeding after uterine atony showed that the method does not affect fertility, while it can be combined with other techniques such as the Bakri tamponade balloon and the B - Lynch suture. Simultaneously showed that by adding ligation of the internal iliac arteries the percentages of Obstetric hysterectomy can be significantly reduced, while in case of severe retroperitoneal hematoma method may be the only one that can save the patient's life [53]. Similarly, Wang and his associates in 2019 analyzing them results of their study, the purpose of which was to evaluate its management severe postpartum hemorrhage with bilateral ligation of internal iliac arteries showed that bleeding was effectively controlled in 8 of 9 patients ( success rate 88.9% ), although their initial conditions were

insufficient. None of the patients underwent obstetric hysterectomy, either showed severe immediate postoperative complications [54].

#### 4.5. Uterine Arteries Embolism

Alternative option of invasive radiology for the treatment of mass of obstetric bleeding, regardless of the etiology or mode of delivery is the embolization of the uterine arteries which at the same time allows its maintenance of female fertility [55]. On the contrary, the embolization of the ovarian arteries beyond many technical difficulties it presents in conjunction with their embolization uterine arteries is considered a controversial treatment option, as it is estimated that could significantly increase the risk of future ovarian dysfunction [56]. Uterine artery embolization is currently a key treatment option for severe postpartum hemorrhage not responding to conservative treatment, due to the low aggression and good efficiency provided in total of cases [57, 58, 59]. Cases in which there are observed increased method failure rates are estimated to be those manifested by disseminated intravascular coagulation and massive blood transfusions are required to control bleeding [60,61]. Recently in 2018, Aoki and his team analyzing the results of their study, the purpose of which was to evaluate to efficacy of their embolization uterine arteries in the management of primary postpartum hemorrhage (uterine atony in 82% of cases) and the determination of the factors that related to the clinical outcome, especially in relation to the ovary, showed that the percentage success of the method concerned 85% of the cases, while estimating that in some cases to control the bleeding was needed and embolization of the ovarian arteries [62]. In a previous study, Wang and colleagues, evaluating the efficacy and safety of uterine embolism arteries in the management of primary postpartum hemorrhage in cases of placenta percreta showed that with a technical success rate of the method of 100%, the bleeding was tested in 17 of 18 patients (94% success rate) during of the monitoring period. In one patient only with persistent bleeding obstetric hysterectomy was considered necessary [63].

#### 4.6. Obstetric Hysterectomy

Failure to control postpartum hemorrhage with preservatives and less invasive means requires the decision to perform obstetric hysterectomy, with all the complications that she may have for the mother, and most importantly of course unexpected and definitive end of a woman's fertility [64]. The first successful obstetric hysterectomy was performed by Eduardo Porri in 1976 [65]. Since then the operation has had to be performed in many cases with postpartum hemorrhage threatening the life of the pregnant woman. According to recent bibliographic reports, the incidence of obstetric hysterectomy ranges from 0.20 to 5.09 per 100 pregnancies worldwide. The atony and the rupture of the uterus which for many years was considered its most common indication of obstetric hysterectomy, the last 20 years have given way to placenta percreta probably due to the increasing number of cesarean sections [66,67]. It is estimated that obstetric hysterectomy is more common in developing women countries, as well as in the territory of a previous cesarean section [68].

Recently in 2017, Zhang and his associates analyzing its results study, the purpose of which was the retrospective examination of the emergency and life-threatening pregnant obstetric hysterectomies (subtotal and total hysterectomies without appendectomy), due to postpartum hemorrhage showed that the average surgery time, average blood loss and average number of transfusions erythrocyte units was higher in total hysterectomy compared to subtotal. Although there was no statistically significant difference in maternal complications, the authors concluded that subtotal obstetric hysterectomy is preferable in extremely urgent situations where the patient's life is threatened [69]. Also Huqe and his associates in 2018, from their own experience that included the assessment of risk factors for obstetric hysterectomy using data from Africa, Asia, Europe and the America showed that placenta previa and placenta percreta are associated with a higher risk of hysterectomy after cesarean section. At the same time the authors found that the advanced age of the mother, previous cesarean section and place of residence of the patients were separate risk factors. More specifically, the performance of obstetrics hysterectomy was more common in Asian women (7%) than in those women who were of African descent (5%) [70].

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### 5. Conclusion

Obstetric hemorrhage and its association with maternal morbidity and mortality is a phenomenon that still concerns the obstetrician and gynecological medical world to a significant degree. Although maternal mortality has decreased significantly in recent decades, due to in-hospital deliveries and the availability of blood units for transfusion, death from bleeding, and mainly from uterine atony, is still present in the majority of maternal deaths in developed countries. The best understanding of clearly identified independent risk factors may improve the ability to identify those pregnant women who may be at higher risk for obstetric bleeding, and mainly for postpartum hemorrhage. Bleeding after childbirth, representing a major medical threat worldwide, is estimated today that they need more research to emerge effective and widely accepted prevention strategies necessary for mitigation of maternal morbidity and mortality rates.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest.

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