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Modern approaches to organ-conserving surgical hemostasis in obstetric bleeding

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BACKGROUND: Obstetric hemorrhage is an urgent problem of global health care, since it occupies a leading position in the structure of maternal mortality.

AIM: The aim of this study was to analyze data on hemostasis in obstetric bleeding.

MATERIALS AND METHODS: The article presents a review of the world literature on modern approaches to hemostasis, which take into account new data on the anatomical structure of the female reproductive system.

RESULTS AND CONCLUSIONS: Based on the foreign and domestic literature data, a strict step-by-step implementation of all prescribed measures along with a differentiated approach to treatment that takes into account anatomical features is the key to success in the fight against obstetric bleeding as the main cause of maternal mortality in the world.

Keywords: obstetric bleeding; organ-preserving operations; guided balloon tamponade; uterine segments.

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Современные подходы к органосохраняющему хирургическому гемостазу при акушерских кровотечениях

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Обоснование. Акушерские кровотечения — актуальная проблема мирового здравоохранения, поскольку они занимают лидирующую позицию в структуре материнской смертности.

Цель — проанализировать данные о проведении гемостаза при акушерских кровотечениях.

Материалы и методы. В статье представлен обзор мировой литературы о современных подходах к гемостазу, основанных на новых данных об анатомическом строении женской репродуктивной системы.

Результаты и заключение. Исходя из данных мировой и отечественной литературы, строгое поэтапное применение всех предписанных мер, а также дифференцированный подход к лечению с учетом анатомических особенностей — залог успеха в борьбе с акушерскими кровотечениями как главной причиной материнской смертности в мире.

Ключевые слова: акушерские кровотечения; органосохраняющие операции; управляемая баллонная тампонада; маточные сегменты.

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Maternal mortality remains the main problem of modern obstetrics [1]. Among the causes of maternal mortality, obstetric bleeding occupies a leading position. According to the World Health Organization, 14 million women worldwide experience postpartum hemorrhage every year [2]. The frequency of obstetric bleeding varies from 2.8% to 7.55% in relation to the total number of births [3, 4]. Moreover, 2%–4% of bleeding cases are associated with uterine hypotension in the follow-up and postpartum periods [5]. Despite the decrease in the maternal mortality rate over the past decade, obstetric bleeding consistently ranks first among its causes (21.1%) [6]. Fatal obstetric hemorrhages are complicated by shock, multiple organ failure, acute renal failure, respiratory distress syndrome, and pituitary necrosis (Sheehan syndrome) and claim the lives of approximately 13,000 women of reproductive age each year [7].

The term “obstetric bleeding” is referred to as a set of nosological forms, including bleeding associated with placenta previa and its premature detachment, which is caused by the impaired contractile activity of the uterus and retention of placental parts in the postpartum period, as well as bleeding resulting from ruptures of the soft tissues of the birth canal and pathologies of the hemostatic system [7].

The main risk factors of obstetric bleeding are aggravated hemorrhagic history; congenital or acquired pathologies of the hemostasis system, such as von Willebrand disease, chronic disseminated intravascular coagulation syndrome, and thrombocytopathies; placenta previa or placenta accreta; and prolonged labor, especially if accompanied by polyexcitation and polyhydramnios. In addition, the risk group includes multiparous women (with a history of more than three births), women aged >40 years, and women with second and third degrees of obesity [7, 8].

Based on clinical guidelines, obstetric bleeding is classified as early and late according to its time of onset. Early postpartum hemorrhage occurs within the first 2 hours and late postpartum hemorrhage occurs >2 hours after childbirth [7].

The etiology of early postpartum hemorrhage is reflected in the 4T theory: (1) tone, such as an impaired contractile activity (hypotony or atony) of the uterus; (2) tissue, such as the impaired separation of the placenta and discharge of the placenta as well as retention of placental tissue in the uterine cavity; (3) trauma, including traumas on the soft tissues of the birth canal, rupture of the uterus; and (4) thrombin, which includes pathologies of the hemostasis system. Late postpartum hemorrhage can be caused by retention of placental parts in the uterine cavity and uterine subinvolution, postpartum infectious complications, and defects of the blood coagulation system [7, 10].

The most common etiological factor of obstetric bleeding is hypotony or atony of the uterus. The modern protocol for

the provision of medical care for hypotonic uterine bleeding implies a strict sequence and phasing of measures, taking into account the blood loss volume and onset of bleeding [4, 7]. At the first stage of obstetric bleeding management, external blood loss is determined by visual assessment or gravimetric method, and vital functions of the body (heart rate, blood pressure, and S_pO_2) are analyzed. Then, guidelines recommend the provision of venous access by catheterization of two peripheral veins, collection of blood samples for laboratory research (coagulogram and clinical blood test), initiation of infusion therapy for replacement, and injection of uterotonic drugs. Moreover, it is necessary to examine the birth canal to identify ruptures and close them as well as perform a manual examination of the uterine cavity under adequate anesthesia [7].

At the second stage, a controlled balloon tamponade of the uterine cavity is performed [7, 11]. This technique assumes a triple mechanism of action: (1) compression of the placental site, (2) stimulation of the contractile activity of the uterus, and (3) reduction of uterine blood flow [11].

In 2005, Prof. Jaraquemada from Argentina was considered the first to introduce new terms into the anatomy of the female reproductive system, i.e., the so-called S_1 and S_2 segments [12]. According to him, the S_1 segment is the body of the uterus, and the S_2 segment includes the lower segment and cervix, upper third of the vagina, and adjacent areas of the parametrium [12, 13]. The blood supply to the body of the uterus (segment S_1) is predominantly provided by the ascending branch *a. uterina* and minimally by the descending branches of *a. ovarica*. The blood supply to the S_2 segment is unique. The S_2 segment contains a huge number of arteries of various origins (including the *a. interna pudendis*, *a. inferior vesiculus*, and *a. vaginalis*) with maximum efficiency [13]. In addition, the lower segment has several morphofunctional features that provide active sources of ongoing bleeding, such as the reduced contractile activity of the lower segment of the uterus due to the scarcity of muscle fibers, diminished effect of uterotonic drugs on this area of the uterus, and arteries that supply blood to the lower segment are located in the retroperitoneal space, which will complicate access to them. Therefore, all traditional methods of stopping bleeding associated with bandaging *a. uterina* are ineffective [12].

With low placentation or placenta previa in the lower segment, a *de novo* uteroplacental blood flow system is formed, and stopping bleeding from the vessels of the placental site is characterized primarily by a powerful contraction of the surrounding muscle fibers, which are insufficient in the lower segment [12].

Given the above, devices containing an intrauterine balloon filled with fluid and a vaginal module, the so-called Zhukovsky two-balloon module, are effective for bleeding from the S_2 segment [14, 15].

Some authors regarded guided balloon tamponade as a diagnostic criterion for the need to move to the third stage and, if the transition is inevitable, as a way to “buy time” to transport the patient to the operating room [16].

If the aforementioned measures are ineffective and massive uterine bleeding is persistent, interventions in the third stage of treatment are implemented, which include conservative (compression sutures, ligation of uterine vessels or internal iliac arteries, embolization of uterine vessels) and radical (hysterectomy) methods of stopping bleeding [3].

Based on the literature data that hysterectomy under conditions of hemorrhagic shock leads to a twofold increase in blood loss, organ-preserving operations are highly relevant [14, 17]. These methods allow not only to achieve a decrease in maternal mortality from massive blood loss but also to preserve the uterus as an organ, that is, not to lose reproductive and menstrual functions.

According to the concept of uterine segments by Jaraquemada, to stop bleeding from the body of the uterus (segment S_1), it is effective to reduce blood flow directly to *a. uterina*, which can be achieved by applying compression sutures, ligation, or embolization of the uterine arteries, as well as ligation of the internal iliac arteries [12].

One of the organ-preserving methods of treating massive obstetric bleeding is the use of compression sutures. Known compression suture techniques include B-Lynch sutures, Pereira sutures, U-sutures, and square sutures. The choice of a compression suture technique depends on the location of the bleeding, severity of blood loss, and experience of the surgeon [2, 18].

To stop obstetric bleeding, an organ-preserving technique of surgical hemostasis can be employed, such as ligation of the uterine vessels. Philippe et al., Hebisch, and Huch described the ligation of uterine vessels through the vaginal approach. However, since the procedure is performed “blindly,” injury to the artery and ligation of the ureter are highly probable. In most cases, uterine vessels are ligated through transabdominal access [16].

The development of technologies and integration of various medical disciplines have made embolization of the uterine arteries possible to relieve massive obstetric bleeding.

Vascular embolization in obstetric bleeding was first described by Brown et al. in 1979 [19]. Uterine artery embolization is 75%–100% effective in stopping massive obstetric bleeding [20]. This technique can only be used in patients with stable hemodynamic status. This method is rarely used because it requires expensive equipment and special training of personnel [19, 20]. The main complications of uterine artery embolization are hematomas at the injection site, infection, uterine necrosis, as well as side effects caused by contrast administration [20].

Ligation of the internal iliac arteries (VPA) was first described at the end of the 19th century. This technique was used by surgeons to stop bleeding from the pelvic organs, while in obstetrics, Saggara et al. (1960) and Reich and Nechtow (1961) were the first to perform ligation of the VPA [13, 16]. This manipulation is performed by an angiosurgeon. In 2009, Kurtser described the physiological course of subsequent pregnancies after WPA ligation. However, there is a high risk of developing complications, such as ischemia of the lower limb due to incorrect ligation of the common or external iliac artery, ligation of the ureter, and damage to the internal iliac vein, which limit the use of this technique in urgent situations, and it requires an angiosurgeon. WPA ligation is possible only in women with stable hemodynamic status [16].

However, if any of the above methods succeeded in reducing blood flow in the *a. uterina*, the collateral circulation in other arteries anastomosed with it will contribute to the total blood loss, which is especially typical for the S_2 segment [12].

Based on worldwide and domestic data, strict step-by-step implementation of all prescribed measures, as well as a differentiated approach to treatment, taking into account anatomical features, is the key to success in treating obstetric bleeding, which is the main cause of maternal mortality worldwide.

ADDITIONAL INFORMATION

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