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Review article

Balloon tamponade in the management of postpartum haemorrhage: a review

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Obstetric haemorrhage is a significant contributor to worldwide maternal morbidity and mortality. Guidelines for the management of postpartum haemorrhage (PPH) involve a stepwise escalation of pharmacological and eventual surgical approaches. The method of uterine tamponade using balloons has recently been added to the armamentarium for managing PPH. There are various balloons available including the Bakri, Foley, Sengstaken–Blakemore, Rusch and condom catheter. This paper reviews these uterine tamponade technologies in the management of PPH.

Keywords Balloon tamponade, intrauterine, management, postpartum haemorrhage, review.

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Background

Obstetric haemorrhage is a significant contributor to worldwide maternal morbidity and mortality.[1,2] In Australia and the UK, haemorrhage features within the top four causes of direct maternal death as reported in the latest triennial reports.[3,4]

Guidelines for the management of postpartum haemorrhage (PPH) involve a stepwise approach including the exclusion of retained products and genital tract trauma. Uterine atony, which is the most common cause,[5] is dealt with uterine rubbing and various uterotonic agents such as oxytocin, ergometrine, misoprostol and prostaglandin F2α (PGF2α).[3,6–8]

If these attempts prove to be unsuccessful and the woman is not already having a caesarean section, a laparotomy is considered. During this time, various surgical interventions may be used. These include internal iliac artery ligation, uterine compression sutures and peripartum hysterectomy to control the life-threatening haemorrhage.[9–11]

Recently, uterine balloon tamponade has been added to this armamentarium in the management of PPH.[7,12–14] The purpose of this paper was to review the various uterine tamponade technologies currently available for the management of PPH.

Uterine tamponade

One of the earliest methods of achieving a tamponade effect to control PPH was by uterine packing.[15]

The possibilities of trauma, infection and ineffective packing resulting in concealed bleeding together with the increasing effective pharmacological agents to treat uterine atony such as ergometrine and syntocinon resulted in a gradual reluctance in use.[16] Despite the declining popularity, in units where uterine packing was commonly employed, data suggested that it was effective.[17,18] In one series of 163 cases, 158 (97%) of these resulted in 'immediate control of bleeding'.[19]

Sterile gauze was invariably used for uterine packing, but more recently, balloon technology has been used to tamponade the postpartum uterus to control haemorrhage. This involves inserting a rubber or silicone balloon into the uterine cavity and inflating the balloon with normal saline. The balloons in descending order of relative cost include the Sengstaken–Blakemore tube, the Bakri balloon, the Rusch balloon, Foley catheters and the condom catheter balloon (Tables 1 and 2, Figures 1 and 2).

Currently, the intrauterine balloon is believed to act by exerting in inward-to-outward pressure 'that is greater than

the systemic arterial pressure' to prevent continual bleeding.[35] More recently, an alternative mechanism of action has been proposed, which involves the hydrostatic pressure effect of the balloon on the uterine arteries.[28]

Many of these balloons have previously been used to control haemorrhage at other anatomical sites, including the bladder[36] and oesophagus,[37] as well as to control PPH from vaginal lacerations.[38]

Furthermore, these same technologies have been used in gynaecological conditions in which bleeding is problematic, for example following first- and second-trimester termination of pregnancy,[20,39] cervical pregnancy,[40–44] knife cone biopsy,[33] laser ablation of the endometrium, dysfunctional uterine bleeding,[45] multiple vaginal lacerations[46] and bleeding from a cervical stump following a post-caesarean section subtotal hysterectomy.[47]

Bakri balloon

Bakri first published the concept of intrauterine balloon technology in the management of haemorrhage secondary to placenta praevia–accreta during caesarean section with or without bilateral hypogastric arterial ligation.[48] Multiple urinary Foley catheters were inserted together with a 'haemostatic substance' applied to the oozing inner surface of the lower uterine segment to function as a 'haemostatic cushion'. The uterine incision site was then closed, and each of the balloons was inflated with 35–75 cm^3 of saline or water. Gentle traction was then applied to obtain a continuous tamponade effect, and the vagina was packed.

The catheters were then tied together, and an examination glove or plastic bag was used for the collection and measurement of blood loss. This was suggested to help prevent blood collection inside the uterine cavity and provide an accurate estimation of bleeding.

Later, a 'balloon device for controlling capillary/venous bleeding and surface oozing' in cases of 'placenta praevia with variable degrees of accretism' was described[49] (Figures 1 and 2). The now termed Bakri 'SOS' (Surgical Obstetric Silicone) balloon was described with a capacity of up to 500 ml of saline achieving a 'pressure and tamponade effect to control the bleeding state'.

A subsequent article described the successful use of the Bakri (SOS) balloon in four women with PPH resulting from a low-lying placenta/placenta praevia[20] (Table 1).

Foley catheters

Both single and multiple Foley catheters have been used in the management of PPH[48] (Table 1, Figures 1 and 2). In one case, despite uterine curette and failed uterine packing using dry sterile gauze, five Foley catheters were inserted into the uterine cavity.[33] They were inflated with 80 ml normal saline to achieve haemostasis and subsequently removed after 36 hours without further bleeding (Table 1). Three other cases of single Foley catheters, filled to 30–50, 80 and 110 ml, respectively, were used in postpartum haemorrhage following unsuccessful use of pharmacological agents and despite uterine curette.[34]

Sengstaken–Blakemore tube

The volume of a postpartum uterus was considered too large for an effective tamponade to be achieved by using a 30-ml Foley catheter balloon as used in gynaecological procedures.[45] Therefore, the Sengstaken–Blakemore two-balloon tube, originally designed for the management of bleeding oesophageal varices, was used.[37] The distal, gastric balloon was filled with 300 ml of normal saline to control uterine atony following vaginal delivery and manual removal of the placenta[23] (Table 1, Figures 1 and 2).

Subsequently, the proximal oesophageal balloon of the Sengstaken–Blakemore tube was used[24] (Table 1, Figures 1 and 2).

Rusch balloon

The greater cost of the Sengstaken–Blakemore tube in comparison to the Bakri balloon and the premise that the uterine cavity requires a balloon capable of being insufflated to a large volume resulted in the use of the urological Rusch balloon[29] (Figures 1 and 2). This balloon is reported having an insufflation capacity of 1500 ml.[30]

The Rusch balloon was first used for continual uterine bleeding after removal of a morbidly adherent placenta and an adherent succenturiate lobe. In the former case, balloon application followed a failed Sengstaken–Blakemore tube application and unilateral uterine artery embolisation. The other uterine artery being inaccessible for embolisation. In both cases, the Rusch urological balloon was inflated with 400–500 ml of warm saline and removed after 24 hours following deflation at a rate of 20 ml/hour[29] (Table 1).

Condom catheters

The principle of a fluid-filled structure exerting a tamponade effect to stop bleeding[36,37] has also been exemplified by the use of condom catheters in the management of PPH. This 'Sayeba's method of PPH control' was used in a prospective study of 23 cases[31,32,50] (Figures 1 and 2). A latex condom was inserted into the uterus by means of a size 16 rubber catheter and inflated with 250–300 ml of isotonic saline until the bleeding was controlled. The condom catheter was then removed after 24–48 hours (Table 1).

Two further cases using this condom catheter were described in the management of PPH in women with impaired coagulation[32] (Table 1). In the first case, a condom tied with silk to the tip 3–4 cm of the Foley catheter was placed in uterus. The condom was inflated (250 ml saline) until bleeding was reduced. The proximal end of catheter was ligated to prevent backflow, and the vagina was packed with

Table 1. Balloon tamponade devices

Balloon device	Number of cases*	Timing of use (number of cases)	Cause of PPH (number of cases)	Use of uterotonic agents	Failed surgical measures	Additional surgical measures (number of cases)	Route of balloon placement
Bakri[d, t, p]	4	Caesarean section (2); postdelivery (2)	Placental site (2)	Not mentioned		Hypogastric a. ligation (2)	At caesarean section from above and transvaginal
Bakri	5	Caesarean section (5)	Uterine atony (5)	Yes	Uterine artery ligation	B-Lynch suture	Transvaginal (presumed)
Sengstaken–Blakemore[a, e, t] or Bakri	22	Caesarean section (9); vaginal delivery (10)	Uterine atony (11); retained placenta (5)	Yes		Embolisation (7)	
Sengstaken–Blakemore[a, g]	1	Vaginal delivery	Uterine atony/DIC	Yes			Transvaginal
Sengstaken–Blakemore[a, e]	1	Vaginal delivery	Uterine atony (coagulopathy)	Yes	Uterine curette		Transvaginal
Sengstaken–Blakemore[a, e]	16	Caesarean section (6); vaginal delivery (10)	Uterine atony (10); retained placenta (4); cervical laceration (1); haematological I condition (1)	Yes			Transvaginal
Sengstaken–Blakemore[b, c, e]	17	Caesarean section (9); vaginal delivery (8)	Uterine atony (10); placenta accreta (7); genital tract trauma (2)	Yes	Ligation of uterine, round and utero-ovarian pedicles	Embolisation because bleeding resumed when balloon was withdrawn 2, 4 and 7 hours (3)	Transvaginal/ through hysterotomy
Sengstaken–Blakemore[b, g]	1	Caesarean section	Placenta accreta	Yes	Oversewn placental bed		Transvaginal
Sengstaken–Blakemore[b, p]	1	Vaginal delivery	Uterine atony	Yes			Transvaginal
Rusch	2	Vaginal delivery	Morbidly adherent placenta (1); retained cotyledons of adherent succenturiate lobe (1)	Yes	Left uterine artery embolisation, right side not accessible Failure of SBT		Transvaginal
Rusch[p]	8	Caesarean section (4); instrumental delivery (1); vaginal delivery (3)	Uterine atony (4); adherent placenta (3)	Yes			After caesarean section (2); transvaginal (6)
Condom catheter[p]	23	Caesarean section (6); instrumental delivery (3); vaginal delivery (14)	Uterine atony (20); placenta praevia/morbid adhesion (3)	Yes			
Condom catheter[p]	2	Vaginal delivery	Uterine atony (1)	Yes			Transvaginal
Foley	1	Vaginal delivery	Uterine atony (recurrent)	Yes	Uterine packing with sterile gauze, Uterine curette		
Foley[d]	2	Vaginal delivery	Placental remnants	Yes	Uterine curette		Transvaginal

rolled gauze to prevent the condom catheter from slipping out. The bladder was continuously drained, and oxytocin was administered for 12 hours. The condom catheter was removed after 32 hours.

The second case involved a woman at 31 weeks of pregnant who presented with placental abruption. Following induction of labour and stillborn delivery, a PPH ensued. A condom catheter was inserted and then removed after 24 hours. Both cases were successfully treated (Table 1).

Balloon design

Although the various balloons attempt to achieve a tamponade effect on the uterus, they are not identical in design. They differ with respect to balloon shape, volume and drainage of the uterine cavity (Figure 1, Table 2).

Balloon shape

The shape of the balloons not only differs with respect to each other (Figure 1) but also as they are filled with fluid (Table 2). Furthermore, for those balloons with a drainage channel, the degree to which the distal surface of the balloon contacts the uterine fundus will depend on the length of the drainage tip (Table 2, Figure 2). In the case of the Sengstaken–Blakemore balloon, the tip is usually cut to allow a better fit between the balloon and the uterine fundus. In other studies, the distal gastric balloon is folded back when the oesophageal balloon is insufflated[26] (Table 1).

Balloon device	Volume in balloon (average)	Oxytocin infusion after placement	Antibiotic usage (duration)	Specific pain relief	Duration of balloon placement (average)	Failure of balloon placement	Failure of balloon tamponade	Successful management of PPH	References
Bakri[d, t, p]	500 ml				20–24 hours			4	Bakri *et al.*[20]
Bakri	60–250 ml (100 ml)		Prophylactic (while balloon in place)		10–24 hours (11 hours)			5	Nelson and O'Brien[21]
Sengstaken–Blakemore[a, e, t] or Bakri	Bakri: 120–750 ml (282 ml); Sengstaken–Blakemore: (28 6 ml)			Epidural anaesthesia or intravenous sedation	2–59 hours (18 hours)	3	1	18	Dabelea *et al.*[22]
Sengstaken–Blakemore[a, g]	300 ml	Yes	Yes (48 hours)		48 hours, deflated at 20 ml/hour			1	Katesmark *et al.*[23]
Sengstaken–Blakemore[a, e]	50 ml				Deflated at 10 hours, removed at 30 hours			1	Chan *et al.*[24]
Sengstaken–Blakemore[a, e]	70–300 ml (167 ml)	8 hours, 40 units in 500 ml	Yes (24 hours)	Minimal analgesia or regional and general anaesthetic	8 hours 55 minutes – 43 hour 40 minutes (26 hours 14 minutes)		2[s]	14	Condous *et al.*[25]
Sengstaken–Blakemore[b, c, e]	120–370 ml (256 ml)	2–82 hours	Broad spectrum	Regional or general anaesthesia (for manual exploration)	3.5–82 hours, deflated over 30 hours – mean		2[s]	15	Seror *et al.*[26]
Sengstaken–Blakemore[b, g]	180 ml	8 hours	Cefuroxime/ metronidazole	Spinal anaesthesia	8 hours			1	Frenzel *et al.*[27]
Sengstaken–Blakemore[b, p]	320 ml	Yes		Anaesthetic				1	Cho *et al.*[28]
Rusch	400 and 500 ml	24 hours						2	Johanson *et al.*[29]
Rusch[p]	240–1000 ml	Over 24 hours, 40 units in 1 l normal saline	Yes (24 hours)	Regional and general anaesthesia	6–24 hours, deflated in stages 100–200 ml	1		7	Keriakos and Mukhopadhyay[30]
Condom catheter[p]	200–500 ml (336.4 ml)	'At least 6 hours'	Prophylactic antibiotics amoxycillin, metronidazole, gentamicin (7 days)		24–48 hours, deflated over 10–15 minutes			23	Akhter *et al.*[31]
Condom catheter[p]	250 ml	12 hours	Broad-spectrum response to 'fever'	Anaesthesia	24 and 32 hours, deflated and removed			2	Bagga *et al.*[32]
Foley	400 ml–5×80 ml	'Continuous infusion'	Prophylactic antibiotics		36 hours			1	De Loor and van Dam[33]
Foley[d]	80 and 110 ml	Intravenous oxytocin	1 g cefazolin before procedure		7 hours and 24 hours			2	Marcovici and Scoccia[34]

a, tip cut; b, tip modification not mentioned; c, more than one cause identified; d, drainage volume 100–460 ml; e, oesophageal balloon used; g, gastric balloon used; p, vaginal pack used; s, includes genital tract trauma; t, traction used.
DIC; disseminated intravascular coagulopathy SBT, Sengstaken–Blakemore Tube.
*Greater than 20 weeks of gestation.

Users of the Sengstaken–Blakemore balloon suggest that 'the tubular oesophageal balloon of the tube would conform more to the shape of the uterine cavity to achieve a haemostatic effect compared to the stomach balloon or a Foley catheter'.[25] Others describe the Rusch balloon and the condom catheter as 'conforming naturally to the contour of the uterus'.[29,31]

Balloon volume

From the product literature, there are different recommended capacities for each of the balloons or balloon components (Table 2). This, however, has not prevented them from being used beyond these recommended capacities.[22] It is unclear whether these recommended volumes are specific to the

Table 2. Specifications of tamponade balloons

	Balloon				
	Foley	Bakri	Sengstaken–Blakemore	Rusch	Condom catheter
Manufacturer/distributor	Tyco	Cook	Tyco	Telemedical	Tyco (Catheter)
Contact details	www.tyco.com	www.cookmedical.com	www.tyco.com	www.telemedical.com	www.tyco.com
Balloon material	Silicone	Silicone	Silicone	Rubber/latex	Rubber/latex
Manufacturer recommended volume	30 ml	500 ml	Gastric 250 ml, oesophagus 150 ml	500–1500 ml	—
Drainage of uterine cavity	Yes	Yes	Yes/No[a]	No	No
Length of catheter shaft[b] (cm)	30.5	43.5	49	28.5	Variable
Length of drainage tip (cm)	2.5	3.6	9.2[b]	N/A	N/A
Balloon number(s) in device	1	1	2	2	2
Channel number(s)	1	1	4[c]	2	2
Insufflation valves	Yes	No	Yes	No	No
Diameter of catheter	10–24F (3.3–8 mm)	24F (8 mm)	16F (5.3 mm)	16F (5.3 mm)	16F (5.3 mm)

a, no drainage of uterine cavity if tip folded; b, distance from balloon base (* in Figure 1) to shaft base (* in Figure 2); c, number of balloons each with insufflation and drainage channels; N/A, nonapplicable.

balloon material (e.g. silicone or rubber) or due to the intended site of placement (e.g. diameter of oesophagus). If the recommended volumes are due to an inherent maximum of the particular balloon, there is a theoretical potential of balloon rupture (see 'Failures and complications').

The product literature on the Bakri balloon (Cook Medical, Bloomington, IN, USA) suggests that a 'predetermined' volume should be used. This volume would be difficult if not impossible to calculate as the uterine cavity is likely to distend as the balloon is insufflated to achieve haemostasis. The advantage of the 'tamponade test' is that it is volume independent and reaches a clinical end-point of no further bleeding. (See 'Clinical effectiveness: the tamponade test'.)

Uterine cavity drainage

Some of the balloons, such as the Rusch balloon and the condom catheter, do not allow drainage of the uterine cavity. Despite being dual channel devices, there is no continuity of the inner channel with the uterine cavity (Figure 1).

By contrast, the remaining balloon devices do allow drainage of the uterine cavity (Table 2). The Bakri balloon has a relatively large bore drainage channel, whereas the other relatively narrow bore devices may block due to fibrin formation as drainage for these balloons is predominantly by gravity.

In the case of the Sengstaken–Blakemore tube when the distal tip is folded, the previously available drainage channel is potentially eliminated[26] (Figure 2, Table 2), whereas cutting the distal tip creates a single wide bore channel for drainage.[23]

Indications, contraindications and timing of use

At present, the Bakri balloon is the only balloon product that is specifically designed for 'the control of postpartum uterine bleeding' (Cook Medical; enclosed instruction leaflet J-SOS1106). However, in settings where it is unavailable, or considered expensive, other balloons have been used to achieve a similar effect.

Indications for use

The various balloon devices have been used alone or in combination with other surgical interventions, such as internal iliac artery ligation and the B-Lynch suture.[21,51] There is no specific hierarchy for the sequence of surgical interventions. Their indication for use is usually after pharmacological methods such as oxytocin, ergometrine and misoprostol have proven to be ineffective for uterine atony (Table 1). By comparison, during certain gynaecological procedures in which heavy bleeding is anticipated, such as the removal of a cervical ectopic, the Foley catheter balloon has been inserted as a prophylactic measure.[42]

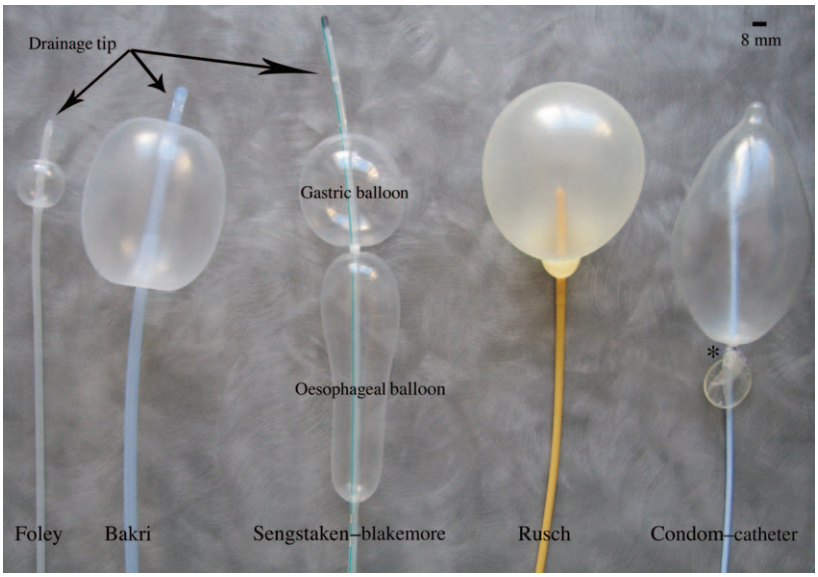

Figure 1. Distal component of tamponade balloons. (Asterisk represents position of suture to attach condom to Foley catheter. Also represents distal point of measurement of balloon shaft length – Table 2 and Figure 2.)

The Sheffield guidelines suggest the use of the Rusch balloon 'as a prophylactic method in cases of women who are at increased risk of PPH and when PPH would jeopardise the pre-existing maternal condition'.[30]

Contraindications

Few contraindications have been highlighted in the use of the balloons. Uterine infection has been mentioned in one report requiring readmission for endometritis, despite receiving antibiotics for 24 hours. The infection was not solely attributed to the Rusch balloon as the woman had a prolonged second stage and instrumental delivery.[30] Another report commented on a 'fever' that responded to antibiotics.[32]

Obviously, the use of rubber/latex products, such as the Rusch balloon and the condom catheter, is contraindicated in those with such an allergy.

Timing of use

Some reports describe the use of the various balloons at laparotomy or at caesarean section (Table 1). If a balloon device is used prior to laparotomy following a vaginal delivery, it may negate the need for a laparotomy.[22,24] If unsuccessful, it will not result in significant delay as insertion is easily achieved. Furthermore, it may also reduce continuing bleeding prior to transfer to the operating theatre or while preparing for a laparotomy.[25] The early use will allow time for

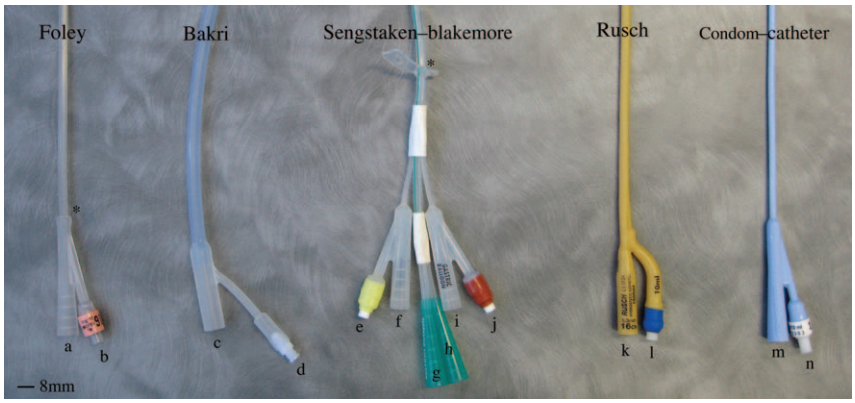

Figure 2. Proximal component of tamponade balloons. (Asterisk represents proximal point of measurement of balloon shaft; b, d, e, f, i, j, k and m indicate insufflation portion of balloon; a, c, g and h indicate drainage portion of uterine cavity. Note that l and n do not contribute to balloon tamponade or drainage. They inflate a balloon within the actual tamponade balloon. There is no drainage of the uterine cavity when using the Rusch and condom catheter – Table 2 and Figure 1.)

resuscitation of the women, obtaining cross-matched blood and arrival of senior help (see 'Clinical effectiveness: the tamponade test').

The United Kingdom Obstetric Surveillance System data on peripartum hysterectomy have demonstrated that early timing of hysterectomy and by inference less blood loss results in less maternal morbidity.[11] Therefore, the early intervention of a balloon device may result in less maternal morbidity secondary to reduced blood loss.

Practical considerations

In using the various balloons for the management of PPH, there are a few practical considerations that arise. These include insertion of the balloon device, use of a vaginal pack, continuing oxytocin infusion, antibiotic usage, pain relief, rate of balloon deflation, timing of removal and clinical effectiveness. These issues are discussed below.

Insertion of balloon device

The various uterine balloons are described as being 'inserted',[23–26,29] 'placed'[32] or 'introduced',[33,34] although there are few specific details as to exactly how this is accomplished. The Rusch and the Bakri balloon have been described as being inserted transvaginally using ring forceps to hold the cervix and inserting the Rusch balloon with a sponge holder forceps. Alternatively, the balloon is 'inserted digitally in the same manner as an intrauterine pressure catheter'.[22] The Bakri (Cook Medical) product information leaflet suggests 'using ultrasound guidance'. Ultrasound scan can also used to confirm correct placement.[28,32]

At laparotomy following a caesarean section, some reports describe the balloon being placed abdominally and then insufflated after the uterine incision is closed. This may potentially result in balloon failure secondary to damaging the balloon by the suturing needle (see 'Failure and complications').

An alternative approach is to close the uterus first and then insert the balloon from the vagina, applying the tamponade test before closing the laparotomy site. This has the advantage of allowing visualisation of the uterus following insufflation.

Use of a vaginal pack

The early publications involving the Bakri balloon suggested the use of a vaginal pack to maintain the balloon in the vagina (Table 1). The use of a vaginal pack in the form of ribbon gauze is recommended in the Sheffield guidelines for the use of the Sengstaken–Blakemore tube.[30] This was also used in the studies involving condom catheters, or alternatively, a second inflated condom was used in the vagina[31,32] (Table 1).

However, the vaginal pack may only be necessary in cases of PPH involving a dilated cervix. The reason for this is that as the balloon is insufflated, it will expand to fit the least resistant space. This may be the vagina in the case of a dilated cervix unless the balloon is somehow maintained within the uterine cavity.

A device such as a Rampley forcep or the operators fingers may be used to gently maintain the distal portion of the balloon at the uterine fundus as the balloon is being insufflated. However, subsequent traction of the balloon, as recommended in the cases of placenta praevia,[20] may result in the balloon being displaced into the vagina if it is not insufflated sufficiently through a dilated cervix.

The option of 'over-inflating' the balloon in the uterus to prevent migration may cause other problems.[30] The first is that distension of the uterus causes significant pain (see 'Pain relief') and therefore one should aim for the minimal amount of uterine distension to accomplish haemostasis. The second problem is a theoretical concern of uterine rupture (see 'Failure and complications').

If a vaginal pack is to be used, then a positive tamponade test needs to be demonstrated prior to placement of the vaginal pack. Otherwise, there is a danger that the pack will obscure any continuing bleeding leading to a delayed diagnosis of ineffective tamponade.

Oxytocin infusion

Despite the use of the various balloons for different causes of PPH, there is no evidence that an oxytocin infusion is obligatory for all causes of PPH (Table 1). The majority of publications describe the use of continual oxytocin infusion following balloon placement (Table 1). However, little specific information is available with respect to the various concentrations, rates and duration of use.

If the syntocinon is continued for the duration of balloon placement, this can range from 2 to 82 hours (Table 1). In such cases of prolonged syntocinon use, there is no mention of monitoring the plasma sodium ion concentration. The possibility of hyponatraemia secondary to the cross-reactivity of the oxytocin with antidiuretic hormone receptors and resultant need to fluid restrict is overlooked. This may be further exacerbated as these women are usually loaded with fluid (blood/blood products/saline) in an attempt to resuscitate them.

Carbetocin, a synthetic analogue of oxytocin, with a half-life of 4–10 times that of oxytocin is available.[52] There were no significant changes in sodium, potassium or chloride values from predrug levels after a single dose of carbetocin when measured at 6, 24 and 72 hours after intravenous injection in nonpregnant women.[53] Therefore, this may be a preferred drug in the presence of a uterine balloon for prolonged uterine contraction.

Although not specifically mentioned, another means of increasing uterine tone is to encourage breastfeeding. However, this may be impractical or declined by the mother.

Antibiotic usage

Antibiotic usage is not empirical. The main aim is to reduce the risk of iatrogenic infection caused by contamination of the uterine environment by the balloon from the vaginal environment. Antibiotics are generally administered at the time of caesarean section or laparotomy. In the studies identified, the antibiotic used is usually a cephalosporin. The duration may be prophylactic (single dose), continued for 24–48 hours or recommended for the duration of balloon usage[30] (Table 1).

Pain relief

Analgesia and anaesthesia are not specifically mentioned in a number of the studies identified (Table 1). The initial placement of the balloons following a vaginal delivery may not require an anaesthetic, but 'analgesia (pethidine) may be used'.[32] It may also be inserted when pain relief has already been achieved, for example in the case of a caesarean section or laparotomy.

Similarly, there is no specific mention of pain relief after insertion. The distended uterus does cause discomfort that can be alleviated by reducing the insufflated balloon slightly. However, a balance must be achieved with respect to the tamponade effect and analgesia requirements.

Rate of deflation

Most papers have removed the balloon within 48 hours (Table 1). Rates of deflation vary from 20 ml/hour to half the volume in the balloon at 12 hours.[23,30] The timing of removal is also suggested to correlate with the availability of senior staff, in case there is continuing bleeding.[30]

Clinical effectiveness: the tamponade test

Various descriptions describe filling the balloons until bleeding is controlled.[22,31,50] This tamponade test[25] is considered 'positive' if control is achieved following inflation of the balloon.[7] Although this test was originally coined with reference to using the Sengstaken–Blakemore tube, it is equally applicable for any of the balloons.[25,27] The tamponade test serves to formalise the stages of managing the PPH as a 'negative' tamponade test (control of PPH not achieved following inflation of the balloon) suggests that further management, such as laparotomy, or an early course to hysterectomy is necessary[7] (see 'Indications, contraindications and timing of use').

Failures and complications

Few studies report difficulties or failures in using the balloons. Some of these 'failures' may be interpreted as 'complications of placement'. These include obstruction by uterine leiomyomata, inadvertent damage to the balloon during preparation of Sengstaken–Blakemore tube while cutting off the tip, inability to place the balloon due to the presence of a B-Lynch suture[22] and insufficient insufflation requiring two balloons.[26]

Although reports of 'Success' and 'Failure' in the use of the balloons for 'obstetric haemorrhage' exist[14], they do not necessarily include specific indications, methods used, balloon type or reasons for failure. Detailed analysis of the cases tabulated in Table 1 identifies one true failure of tamponade[22] not attributed to unidentified genital tract trauma or spontaneous expulsion.[25,26,30]

Literature with respect to the use of the Sengstaken–Blakemore tube in the management of oesophageal bleeding describe a number of potential, but as yet unreported complications. These include ulceration from the pressure effect of the balloon in the uterus or vagina especially with prolonged use,[54] unrecognised exsufflation,[55,56] uterine rupture from uterine overdistension[57] and uterine perforation during insertion.[58]

Other potential complications include inadvertent perforation of a previously sited uterine balloon during the administration of intramyometrial PGF2α and air emboli if air is used as the distension medium for the balloon.

Future pregnancies

At present, there is a single pregnancy reported following the use of the Rusch balloon[29] and two pregnancies following the use of a Bakri balloon in combination with a B-Lynch suture.[21]

Summary

Postpartum haemorrhage (PPH) is a potentially life-threatening event. In the majority of cases, relatively simple methods are used to avert a disaster, although these are not always employed.[11]

Uterine tamponade using intrauterine balloons appears to be an effective tool in the management of PPH. Overall, from the case reports, retrospective[22,26,30] and prospective studies,[25,31] 97/106 (91.5%) cases were successful when the various balloons have been used (Table 1).

Given that the technology is simple to deploy and with minimal adverse effects, a balloon tamponade method should become a familiar component of existing guidelines for the management of PPH, although not as an isolated form of therapy.

It is hoped that this review paper increases the awareness of the various tamponade balloons and contributes to an evidence-based appraisal of its place in the management of PPH.

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None.

Contribution to authorship

CG reviewed the literature and prepared the manuscript

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