

Uterine compression sutures, an update: review of efficacy, safety and complications of B-Lynch suture and other uterine compression techniques for postpartum haemorrhage

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Received: 10 June 2009 / Accepted: 25 September 2009 / Published online: 16 October 2009
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Abstract Since the advent of uterine compression suture by B-Lynch, numerous techniques have been advocated. We aim to discuss these various techniques with respect to their efficacy, safety, complications, complexity of the technique itself, future fertility and menstrual periods. Since no randomized controlled trials are available, the conclusions are based on weak data derived from observational studies and case series. A success rate of 91.7% has been reported for various uterine compression sutures. There are concerns regarding closure of uterine cavity and blood entrapment resulting in infection, pyometra and adhesions as the uterus will be transfixed from front to back in some of the suturing techniques. Long-term follow-up regarding fertility of patients who had uterine compression sutures is urgently needed. Data on menstrual periods after uterine compression sutures is limited. Our review is limited in nature due to lack of consistent data on many important outcomes and also preclinical variables.

Keywords Postpartum haemorrhage · Uterine compression sutures · Brace suture · B-Lynch suture

Introduction

Postpartum haemorrhage continues to be the most common cause of maternal mortality and is responsible for 25% of the maternal deaths worldwide [30]. Nearly 45% of post partum deaths occur in the first 24 h after delivery [19]. The

Confidential enquiry into Maternal and Child Health Report of 2004 again stated postpartum haemorrhage as a major cause of maternal morbidity and mortality [8]. The B-Lynch uterine compression suture technique to manage postpartum haemorrhage conservatively was first described by B-Lynch [5]. Various techniques (Tables 1, 2) such as Cho's Square Suture and Hayman's modification of the B-Lynch Suture Technique have been introduced adding to more available methods of conservative surgery [10]. B-Lynch suturing technique is particularly useful because of its simplicity of application, life saving potential, safety and capacity for preserving the uterus and subsequent fertility [23]. Published data have confirmed that the B-Lynch surgical technique is safe, effective and free of short and long-term complication [28]. In a recent review Holtsema et al. [17] argued that the B-Lynch technique for postpartum haemorrhage should be an option for every obstetrician. The aim of this review was to critically analyse various modifications of B-Lynch sutures and other similar suture techniques for postpartum haemorrhage with respect to efficacy, safety, complications, ease of the technique, future fertility and menstrual periods.

Materials and methods

We conducted electronic searches in MEDLINE, EMBASE and the Cochrane Library using "B-Lynch", "brace sutures" and "uterine compression sutures" for different suture techniques.

Results

No randomized controlled trials (RCT) were noted. Only observational studies were found.

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Table 1 Different techniques of uterine compression sutures

| Author | Technique |
|-----------|---|
| B-Lynch | Involves lower uterine incision to check for emptiness of cavity and brace suture to the uterus without transfixing the anterior and posterior uterine walls |
| Cho | Multiple square suturing to approximate anterior and posterior uterine walls especially in areas of heavy bleeding |
| Hayman | Two vertical sutures are placed over the fundus effectively sewing the anterior and posterior walls together and one cervicoisthmic suture anteroposteriorly |
| Pereira | Multiple sutures applied longitudinally and transversely around the uterus. Placement of sutures involved a series of bites inserted superficially, taking only the serous membrane and the subserous myometrium without penetrating the uterine cavity |
| Ouahba | Four sutures placed on the uterus with one transverse suture in the middle of the fundus, one transverse suture in the lower segment and one suture on each horn |
| Hackethal | Uterine compression using 6–16 horizontal interrupted U-sutures |
| Bhal | Variation of B-Lynch sutures using two sutures |
| Nelson | Sandwich technique with concomitant use of Bakri balloon in addition to B-Lynch suture |

Table 2 Different techniques of uterine compression sutures

| Year | Number LSCS/VD | Technique | Country | Efficacy | Complications published | Fertility published | Suture in AP diameter of uterine cavity | Uterus opened |
|------|----------------|-----------|-------------|----------|------------------------------------|---------------------|---|---------------|
| 1997 | 3/2 | B-Lynch | UK | 5/5 | Nil | 5 | No | Yes |
| 2000 | 23/0 | Cho | South Korea | 23/23 | Pyometra 1 synechiae 1 | 4/10 | + | No |
| 2002 | 2/1 | Hayman | UK | 3/3 | Adhesions in the peritoneal cavity | – | + | No |
| 2005 | 6/1 | Pereira | Portugal | 7/7 | Nil | 1 | No | No |
| 2007 | 17/3 | Ouahba | France | 19/20 | Nil | 6/8 | + | No |
| 2007 | 7 | Hackethal | Germany | 7/7 | Depression 1 | – | + | No |
| 2005 | 11 | Bhal | UK | 10/11 | Nil | 2 | + | No |
| 2006 | 5 | Nelson | USA | 5/5 | Nil | – | + | Yes |

B-Lynch suture

The B-Lynch suture for treating postpartum haemorrhage has allowed conservation of the uterus and thus preserves fertility. It has been widely used since then and more than 1,800 cases have been reported in the literature so far.

The basic principles of applying the B-Lynch suture are as follows: Firstly, correct positioning of the patient in Lloyd Davis (or Frog Legged) position is essential. After the uterus is exteriorised, bimanual compression should be done to test for potential success, then a transverse lower segment incision made and the uterine cavity checked, explored and evacuated if required. Then the B-Lynch suture (technique described below) is applied correctly with even tension, taking care that there is no shouldering. This should allow free drainage of blood, debris and inflammatory material. Once haemostasis is achieved and the vagina is checked, the abdomen can be closed.

For a left-handed surgeon or the surgeon electing to stand on the left side of the patient, the procedure is as follows (Fig. 1): A No 1 polyglecaprone-25 suture is placed in the uterus 3 cm below the right lower edge of the uterine incision and 3 cm from the right lateral border of the uterus (chromic catgut was used in the original study). The suture is then threaded through the uterine cavity and emerges at the upper incision margin 3 cm above and approximately 4 cm from the lateral border (because the uterus widens from below upwards). The suture (now visible) is passed over to compress the uterine fundus approximately 3–4 cm from the right cornual border. It is then fed posteriorly and vertically to enter the posterior wall of the uterine cavity at the same level as the upper anterior entry point. The suture is pulled under moderate tension assisted by manual compression exerted by the first assistant and then passed back posteriorly in a horizontal direction through the same surface marking as for the right side. Then it is fed through

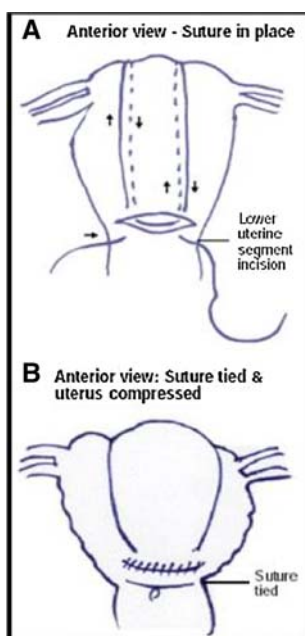


Fig. 1 B-Lynch

posteriorly and vertically over the fundus to lie anteriorly and vertically compressing the fundus on the left side as occurred on the right. The needle is passed in the same fashion on the left side through the uterine cavity and out approximately 3 cm anteriorly and below the lower incision margin on the left side. The two lengths of suture are pulled taut assisted by bi-manual compression. Meanwhile, the vagina is checked for bleeding. Once haemostasis is secured and whilst the uterus is compressed, the surgeon throws a double knot followed by two or three further knots to secure tension. A polyglecaprone-25 suture is recommended because it is user and tissue friendly with uniform tension distribution and is easy to handle.

Prior to introduction of the B-Lynch suture, other surgical methods like ligation of the ovarian, uterine and internal iliac artery were employed. Although effective, these techniques are not always expeditious in controlling bleeding. It is important to note that such suturing techniques may not achieve adequate control of bleeding particularly when there is coagulopathy and diffuse bleeding from an atonic uterus. And delay in effecting surgical technique may further compromise the patient's critical condition. The B-Lynch suturing technique as demonstrated in these described cases has been quick and effective in the control of massive postpartum haemorrhage. The application of the suture itself is far less complicated than either internal iliac artery ligation or hysterectomy plus the operating time is considerably shorter. The immediate haemostatic result of this technique can be seen before closure of the abdomen if the patient is in the Lloyd Davies position.

The B-Lynch technique has been widely performed and has proved to be valuable in the control of massive PPH. About 17 reported failures have been reported after B-Lynch suture technique. It must however be acknowledged that the estimation of failure rate based on case reports is of limited value and most obstetricians do not like to report failures, specifically in case reports. There are no reported instances of serious adverse outcomes from the B-Lynch suture technique if applied properly and early. The 2000–2002 Triennial Confidential Enquiry states no deaths reported in women who had interventional radiology or B-Lynch suture. The distinguishing feature of B-Lynch suture is that it does not sew the anterior and posterior wall together and this is in contrast to other uterine compression sutures.

Square Sutures by Cho

This study was done in the University of Seoul in South Korea in 2000 by Cho et al. [6]. 23 patients with postpartum haemorrhage which did not respond to medical management following caesarean section underwent this technique which involves multiple full thickness square sutures to compress the anterior and posterior uterine walls. The technique (Fig. 2) is as follows: An arbitrary point in the heavily bleeding area is selected and the entire uterine wall from the serosa of the anterior wall to the serosa of the posterior wall, through the uterine cavity, is sutured. Another arbitrary point 2–3 cm lateral above or below the first suture point is selected, and the entire uterine wall from the posterior to the anterior is sutured again. From another point in the heavily bleeding area, 2–3 cm lateral above or below the second suture point, uterine cavity walls are penetrated again, this time from the anterior to posterior. Then, from the third suture point, another point is set so the points form a square and penetrate the uterine walls from the posterior to the anterior. Finally, a knot is tied as tightly as possible. Selected areas of heavy bleeding are square sutured because authors believe that if the procedure included the entire cavity, blood drainage might be compromised and compression diminished.

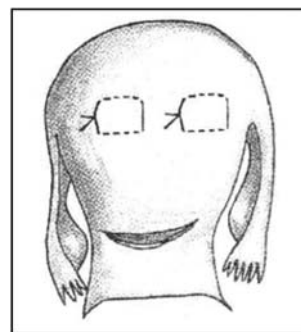


Fig. 2 Cho

In all 23 cases, bleeding decreased markedly and hysterectomy was avoided. All resumed normal menstrual flow after surgery. In four cases, further pregnancy was achieved after this method was used. Authors concluded that haemostatic multiple square suturing is easy to perform and that the operating time is short. The drawback of this technique is the possibility of pyometra and indeed pyometra was reported in one patient and Asherman's syndrome was reported in one case. It involves piercing the uterus multiple times (in one case the uterus was pierced 32 times) and also it involves suturing the anterior and posterior wall together which can predispose to pyometra. The efficiency of these techniques may be less than the B-Lynch technique [25].

The Hayman technique

Hayman et al. [16] reported about their techniques of uterine compression suturing. This is essentially a compression suture which does not require opening the uterine cavity. It is quicker to perform but does not allow for exploration of the uterine cavity under direct vision. The morbidity and fertility outcome data are currently unknown. The authors described simple modifications of B-Lynch technique involving three clinical case scenarios illustrating the context in which the sutures may be used.

The first case was a posterior placenta praevia extending across the internal os. Two isthmic cervical compression sutures were therefore inserted to stop bleeding from cervical area. Tightening these sutures markedly decreased the loss from the lower segment. Two vertical compression sutures was then placed and tied over the uterine fundus. (Fig. 3). In the second case the patient bled after manual replacement of uterus after inversion and did not respond to medications. Four vertical sutures were inserted passing the needle from front to back above the bladder reflection in the line where a lower segment incision would have been made and tied anteriorly. In the third case, a standard B-Lynch suture succeeded in compressing lateral margins but floppy central portion continued to bleed. Four additional vertical compression sutures added and were effective. The authors claimed that their procedure was less complex to perform. No hysterotomy was required.

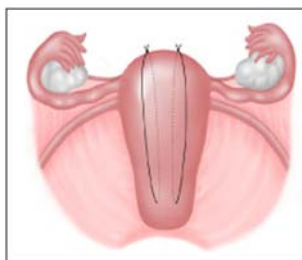


Fig. 3 Hayman's

This is only a case series of three reports which means that a larger trial is needed to fully evaluate the efficacy and complications. The authors advocate passing a pair of closed artery forceps or similar instrument to ensure that the cervical lumen remains patent if transverse compression sutures are required. No comment has been made about the fertility of the patient after the procedure. Long-term follow-up data is lacking but it adds to the database of simple procedures in management of PPH. The possibility of occlusion of uterine artery and blood entrapment due to transfixation of uterus from front to back remains.

Cotzias et al. [7] described two cases of uterine compression suture without hysterotomy, described in the literature previously by Hayman et al. [16]. They considered in detail the suture material used for the technique and concluded that it is inappropriate to use a non-absorbable suture [7]. Modified compression sutures are being used increasingly and a wide variety of suture materials are being chosen. Authors advocated avoiding the use of non-absorbable or slowly absorbable sutures. Ghezzi et al. [12] reported their experience with Hayman's technique. This was performed by them on 11 women with massive PPH. Of these, ten were successfully treated without further interventions. One woman ultimately required a hysterectomy. Postoperative course was uncomplicated in all the cases. The median follow-up time was 11 months (range 1–19).

The Pereira technique

Pereira [22] from Portugal published a report on his modified compression suture for postpartum haemorrhage. This included series of longitudinal and transverse sutures around the uterus (Fig. 4). Placement of the sutures involved a series of bites inserted superficially taking only the serous membrane and the sub serous myometrium without penetrating the uterine cavity. Two or three transverse circular sutures were placed first, starting in the anterior aspect of the uterus, crossing the broad ligament towards the posterior aspect of the uterus then crossing the opposite broad ligament towards the anterior aspect and tying the suture over the anterior aspect of the uterus. The number of bites taken depended on the size of the uterus. Whenever the suture crossed the broad ligament, it was important to select an avascular area and to be sure that the fallopian tube, the uteroovarian ligament and the round ligament were not included in the suture. The last transverse circular suture in the lower uterine segment served as an anchor for 2 or 3 longitudinal sutures. Each longitudinal suture started on the dorsal side of the uterus using a knot to fix it to the lowest circular suture and ended on the ventral side using another knot attached to the lowest transverse suture. None of the sutures penetrated the endometrial cavity. Total number of cases in his series reported was seven. The procedure

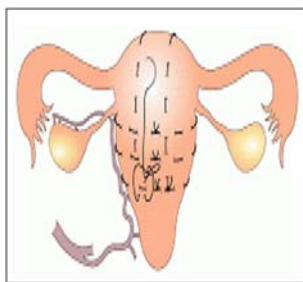


Fig. 4 Pereira

took average time of 5 min although the range was from 4 to 7 min. Hysterectomy was avoided in all cases.

This technique does not involve penetrating uterine cavity and therefore decreases the risk of infection. Authors claim that due to the small size of the bites applied to the uterus, the risk of a loop of bowel or omentum coming between the uterus and the suture with puerperal involution is reduced. The reported incidence of intestinal obstruction or omental necrosis after uterine compression sutures is extremely low with any of the techniques and especially with the advent of suture materials that will be absorbed in less than 2 weeks, the possibility of bowel or intestinal entrapment is remote. One theoretical advantage is that as each suture is made up of a succession of small bites of the uterus, it results in distributing the pressure more evenly and therefore more effective compression. This study is limited by the small number of cases. Although the authors have claimed that average time taken was 5 min, taking superficial multiple bites for each of the vertical and transverse sutures may take more than 5 min.

Stein et al. [26] followed Pereira's technique in five women who underwent a Caesarean section and developed severe postpartum haemorrhage. Compression sutures of the uterus as described by Pereira were successful in all cases. The follow-up was uneventful in all cases.

The Ouahba technique

Ouahba et al. [21] reported their technique of compression suture of the uterus. It was a retrospective study of 20 women with uterine atony and postpartum bleeding that did not respond to medical management. The procedure involved four sutures, 2 transverse and 2 near the horns (Fig. 5). The average time taken was 12 min (range 9–15 min). Uterine compression suturing was sufficient to stop the bleeding immediately in 95% of women. None of the 20 women developed complications related to the procedure. All the women recovered normal menstrual cycles. Authors concluded that their technique of uterine compression suturing is a simple conservative procedure and that it can be performed quickly and does not seem to decrease fertility.

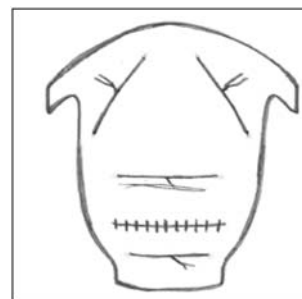


Fig. 5 Ouahba

Again this study was also limited by the small number of cases. A suture is tied in each of the uterine horn which may possibly give rise to theoretical risk of infertility due to infection at the site of uterine ostia or even by occlusion of ostia. The authors have claimed that among the eight women who tried to conceive, six (75%) went on to have a term delivery.

Modified U suturing technique (Hackethal)

In 2007, Hackethal et al. reported their technique of modified U suture. This technique was performed on seven patients with Postpartum haemorrhage after Caesarean section. It involved placing 6–16 horizontal interrupted sutures (Fig. 6) starting at the fundus and ending at the cervix [15]. The average time taken was 8.4 min (range 4–15 min). Hysterectomy was avoided in all cases. In all cases, treatment was successful, the haemorrhage was controlled and the uterus preserved. Normal menstruation patterns had resumed in the five patients who replied to the follow-up

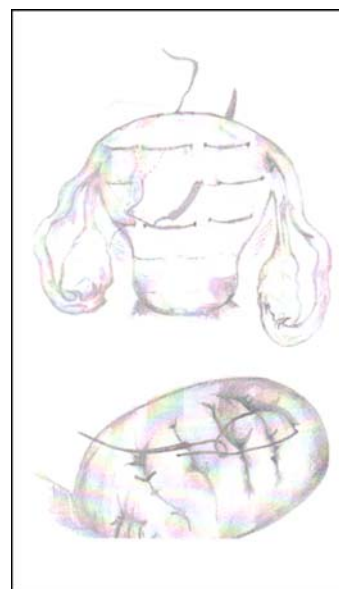


Fig. 6 Hackethal

questionnaire. No surgery related morbidities were noted on clinical examination of six patients who attended for follow-up at 6 months. The authors could not comment on fertility as nobody had tried to conceive by the time of follow-up. Authors concluded that the technique was simple to perform in an emergency situation. The shortcomings of this study are the limited number of patients and the short follow-up. The follow-up period was only 6 months. Compared to other described compression sutures authors postulate that, the interrupted single U-sutures provide more effective compression during uterine involution because several areas are compacted and that if one suture fails, the remainder is not affected. Within this limited period of follow-up, none of the patients desired further pregnancies and therefore no pregnancies occurred. This limits the data regarding fertility.

Other techniques

Bhal et al. [4] from Cardiff reported another modification of the B-Lynch technique involving 11 cases. This was a descriptive study of 11 patients with major postpartum haemorrhage after caesarean section in which two compression sutures were placed. Two sutures were used to create a belt and brace like effect secured with two knots in the anterior–inferior margin of the lower uterine segment (Fig. 7). The reason for modification of B-Lynch approach was due to the reduction in use of catgut and the ease of using two rather than one suture to achieve compression. Hysterectomy was required in one case. Two women have conceived and others had not wished to have more pregnancies when the study was reported. The technique is basically a variation of the B-Lynch method. There is no difference from the B-Lynch technique apart from the number of sutures. Some surgeons might find using one suture easier than using two sutures.

In 2006, Nelson from Canada reported their “sandwich technique” of compression sutures in five patients with atonic postpartum haemorrhage following caesarean section [20]. This method described placing a balloon inside

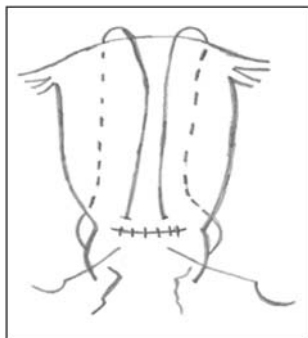


Fig. 7 Bhal

the uterus as well as the compression sutures. Hysterectomy was avoided in all cases. The balloon was in place for a median duration of 11 h (range 10–24 h). No complications were reported. An intrauterine Bakri balloon was placed when B-Lynch technique failed. Sandwich technique cannot be performed with other uterine compression suture techniques as they all occlude the cavity.

Discussion

Efficacy

Doumouchtsis [9] reported a success rate of 91.7% (95% CI, 84.9–95.5%) for various uterine compression sutures. Given the severe nature of postpartum haemorrhage and its associated morbidity and mortality, it is highly remarkable that there have been no RCTs on efficacy of uterine compression techniques so far. Several isolated observations or limited case series of B-Lynch suture have been reported in the literature after the first report was published in 1997. Hysterectomy was avoided in all seven cases in Pereira’s technique. Stein et al. who followed Pereira’s technique reported success in all five cases. Ghezzi et al. using Hayman’s technique reported success in 10 out of 11 cases. Ouahba et al. reported success in 19 of the 20 patients (95%). All seven patients who had U sutures in the study by Hackethal et al. avoided hysterectomy. Nelson reported success in all five patients who underwent the combined technique of compression sutures and balloon. Cho et al. avoided hysterectomy in all 23 patients who underwent multiple square suture technique.

In these reports, the place of the uterine compression suture techniques during the management of PPH widely varied from one case to another. The B-Lynch procedure has been performed prophylactically or following failure of uterotonic agents, intrauterine tamponade, vessel ligation or other procedures such as haemostatic sutures. Due to this heterogeneity and the small cohorts, these studies have limited value on data reported on the effectiveness of the compression sutures to control PPH.

Safety/complications

Some of the techniques to control postpartum haemorrhage such as internal iliac ligation require considerable experience and surgical expertise. Uterine compression sutures generally are easy to perform and are generally without any risk of injury to ureter or vessels. Not all forms of uterine compression sutures are uniformly safe. Gowri [13] reported a case of uterine rupture in the second trimester of a subsequent pregnancy after compression sutures had been taken in the previous delivery. The suture material used

also needs to be absorbable one. Cotzias et al. [7] who followed Hayman's technique advised against using any delayed absorbable or non-absorbable sutures. The issue of sutures going through the uterus anteroposteriorly and thereby causing possible occlusion of the uterine cavity and giving rise to infection, pyometra, synechiae and infertility also needs further studies and database of various techniques needs to be set up. Pyometra was reported in one patient and Asherman's syndrome in another in Cho's study. Ochoa who followed Cho's technique reported one case of pyometra. Ouahba et al. reported complications in none of the women related to the procedure. No surgery related morbidities were noted at follow-up of six out of seven patients who had U sutures in the study by Hackethal et al. Nelson reported no complications in five patients who underwent the sandwich technique. No serious adverse outcomes have been associated with the B-Lynch surgical technique till date [1, 5, 10, 23, 28, 29]. The prevalence of the complications following the B-Lynch suture has seemed to increase in relation to the number of procedures performed [11, 27].

Fertility

In most studies, the fertility data is either not mentioned at all or very limited. This may be due to the small duration of follow-up in these studies. Also, the patients will be very reluctant to experience a recurrence of postpartum haemorrhage and take the risk of a subsequent pregnancy [24]. All the five patients from B-Lynch's first published study have conceived. Api from Turkey reported a case of successful pregnancy after hypogastric artery ligation and B-Lynch suturing technique [2]. Habek from Croatia reported a successful term pregnancy in a 28-year-old patient after previous caesarean section and B-Lynch compression suture [14]. Tsitlakidis reported a follow-up of a case with successful pregnancy 10 years after PPH was managed with the B-Lynch uterine compression suture. This case represents the longest follow-up after the application of the B-Lynch suture [28]. Ghezzi et al. who followed Hayman's technique reported one woman conceiving spontaneously 10 months after the procedure. Since uterine compression suturing, eight women have tried to conceive and six (75%) had a term delivery in the report by Ouahba et al. Hackethal et al. could not comment on fertility as nobody was trying yet when they reported their case series. In 4 out of 23 cases, further pregnancy was achieved after Cho's method was used. The obvious difficulty in various studies was that the studies were published well before the patients recovered from their operation and took the decision to conceive. Long-term follow-up for fertility of patients who had uterine compression sutures is urgently needed.

Menstrual periods

Data on menstrual periods after uterine compression sutures is limited. Ouahba et al. reported that all women recovered normal menstrual cycles. In the study by Hackethal et al., normal menstruation patterns returned in five patients out of seven who returned the questionnaire after having U sutures. Even in Cho's study all patients resumed normal menstrual flow after surgery. Again, although there were no reported cases of amenorrhoea or oligomenorrhoea after any of the uterine compression sutures, the follow-up of patients in all the studies has not been documented completely. Baskett observed a previous B-Lynch procedure during direct visualization of the uterus at the time of subsequent elective caesarean sections in seven cases [3]. This author reported a thin fibrous band between the anterior and posterior wall of the uterine cavity in the lower uterine segment in one case, and in three cases the possible marks of a previous B-Lynch procedure, i.e. fundal grooves, that did not interfere with the pregnancy. In the remaining three cases no complication or marks of the previous B-Lynch procedure was observed. Thus, the initial fears regarding possible anatomical damage due to extreme uterine compression have not been proved.

Conclusions

The management of uterine atony is mainly dictated by hemodynamic status and the desire to preserve fertility. There is a desire to avoid hysterectomy particularly in younger women. Of the various newer suturing techniques described recently, data on efficacy and safety are mainly limited to the small case series reported by the proponents themselves, and long-term follow-up information are still awaited.

The B-Lynch technique in addition to being a life saving procedure by achieving haemostasis and having the capacity for preserving the uterus and thus fertility, the other main advantages of the B-Lynch suture are that it confirms uterine cavity emptiness, satisfactory haemostasis can be ensured soon after application, plus it avoids obliteration of cervical and uterine lumen. There is reduced risk of pyometra and synechiae with B-Lynch suture which have been reported with various other modified techniques such as Cho. No serious complications have reported after B-Lynch technique. Hayman's technique is faster to perform since the uterine cavity is not explored under direct vision but morbidity data and future fertility is not known. Various other techniques of compression sutures for the uterus for postpartum haemorrhage require transfixing the uterus from front to back when placing the sutures. This gives rise to concerns about occlusion of the cavity of the uterus and

entrapment of blood and thereby the risk of infection and synechiae formation. There are no randomized controlled studies to suggest one technique over another but randomized controlled trials may be difficult to perform in practice. Data on fertility and menstruation after the procedures is scarce and limited by the duration of follow-up.

The Confidential Enquiry into maternal deaths in UK has recommended the use of B-Lynch suture. The CEMACH report has recommended formal training for B-Lynch technique. The high success rate of various sutures warrants including this type of procedure in controlling postpartum haemorrhage in curriculum for trainees. It has the advantage of being applied easily and rapidly, and should be taught to all trainees in obstetrics [18]. Our review is limited in nature due to lack of consistent data on many important outcomes and also preclinical variables. Since no randomized controlled trials are available, the conclusions are based on weak data derived from observational studies and case reports.

Conflict of interest statement The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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