The use of uterine compression sutures in the management of patients with severe postpartum haemorrhage in a regional obstetric hospital

MMed Thesis
Obstetrics and gynaecology

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CONTENTS

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I, Dr Dakalo Arnold Muavha, hereby declare that the work on the present dissertation/thesis is my original work (except where acknowledgement indicates otherwise) and that neither the whole work nor any part of it has been, is being or is to be submitted for another degree to UCT or any other university.

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LIST OF ABBREVIATIONS

AIDS	acquired immune deficiency syndrome
ANC	antenatal care
AOL	augmentation of labour
AROM	artificial rupture of membranes
CHT	chronic hypertension
DM	diabetes mellitus
EBL	estimated blood loss
EVAC	evacuation of uterus
FFP	fresh frozen plasma
FDP	fresh dry plasma
GA	gestational age
GDM	gestational diabetes mellitus
HIV	human immunodeficiency virus
HREC	Human Research Ethics Committee
IGT	impaired glucose tolerance
LRTI	lower respiratory tract infection
Miso	misoprostol
MMH	Mowbray Maternity Hospital
MMR	maternal mortality rate
MOD	mode of delivery
MRI	magnetic resonance imaging
NVD	normal vaginal delivery
PET	pre-eclamptic toxaemia
Gest.HPT	gestational hypertesion
PPH	postpartum haemorrhage
RCOG	Royal College of Obstetrics and Gynaecology
RPR	rapid plasma reagin
SB	stillbirth
UCS	uterine compression suture
UCT	University of Cape Town
UP	uterine packing
MFU	multifibroid uterus
HPT	hypertention
GPH	gestational proteinuric hypertension
DIC	disseminated intravascular coagulopathy

LISTS OF FIGURES AND TABLES

FIGURES

TABLES

PROJECT TITLE :

The use of uterine compression sutures in the management of patients with severe postpartum haemorrhage in a regional obstetric hospital

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SYNOPSIS

Background

Postpartum haemorrhage (PPH) is a direct leading cause of maternal death in developing countries including South Africa[1], and atonic uterus is responsible for up to 80% of cases of postpartum haemorrhage[2]. The introduction of the uterine compression suture (UCS) by C B-Lynch revolutionised the conservative surgical management of postpartum haemorrhage. Its use is simple, does not require special training and reduces the need for hysterectomy. Many small studies have been conducted in different parts of the world on its effectiveness but no published studies have been found from Africa. To understand the unique challenges in developing countries, especially those in Africa, it would be relevant to establish if uterine compression sutures are beneficial in a low resource setting for the management of PPH. Accordingly, the aim of the present study was to audit the use of uterine compression suture (UCS) in our regional hospital, with a focus on the circumstances in which it was used and its success rate in treating postpartum haemorrhage.

Methods

This was a retrospective folder review study of all women who had a UCS inserted to treat obstetric haemorrhage in Mowbray Maternity Hospital during the period between January 2010 and June 2016, following ethical approval from the UCT HREC and Mowbray Maternity Hospital's management. Cases were identified from theatre registrars and a designated UCS book. Patients' records were retrieved and data collected and analyzed using the Excel spreadsheet software.

Results

During the 6.5-year study period, there were 132, 612 deliveries in the population served by Mowbray maternity Hospital, of which 102,261 (78%) were by normal vaginal delivery and 30,351 (22%) by caesarean section. A total of 150 UCS cases were identified giving a rate of 0.87 UCS per 1000 deliveries (at MMH and its referral MOUs). Of the 150 cases, 115 (77%) patient files could be retrieved for further

analysis. UCS was performed more commonly after ceasarean section (107; 93%) than after vaginal delivery (8; 7%) The majority were performed by obstetric registrars (73; 63.4%) compared to 21 (18.3%) performed by consultants and by medical officers. The UCS was successful in stopping haemorrhage without the need for hysterectomy in 107 (93%) of all analyzed cases. Among the 8 failures, all required a hysterectomy and one woman died. The majority of UCS (50%) were performed in cases with estimated blood loss over 1000 mls, with 20.9% having blood loss more than 2000mls. Of note, 13.9% had an estimated blood loss (EBL) less than 500 mls (the majority of which were performed by medical officers). Short term morbidity of UCS cases included blood transfusion (42%), admission to ICU (8.7%), post ceasarean section sepsis (9.6%), and prolonged hospital stay (46.1%)

Discussion and conclusion

This study is one of the largest case series and the first done in an African setting. Our success rate of 93% is similar to other previously reported published studies with similar low rates of short term morbidity. Our study confirmed that the success of the UCS is achievable even in low-resource environments and that UCS can be safely performed by surgeons with different levels of surgical expertise (medical officers as well as registrars and consultants).

1. INTRODUCTION AND RATIONALE FOR THE STUDY

Postpartum haemorrhage is defined as loss of more than 500 mls blood from the genital tract after vaginal delivery, or more than 1000 ml after caesarean section.[3] Postpartum haemorrhage is a leading cause of maternal mortality and morbidity. Of all the maternal deaths reported yearly worldwide, 99% occur in developing countries, and about 56% of these deaths occur in Sub-Saharan Africa . Thirty per cent of maternal deaths in developing countries are attributed to postpartum haemorrhage.[4] Hence, to curtail preventable maternal mortality and to improve maternal health, developing countries must have clear, simple, affordable ways to prevent and manage postpartum haemorrhage. In 2015, the UN Maternal Mortality Estimation Inter-Agency Group estimated the maternal mortality rate (MMR) by region. This survey showed that although the MMR in Sub-Saharan Africa(SSA) had decreased between 1990 and 2015 from 1000 to 546 deaths per 100 000, the decline was at the lowest rate globally and SSA still had the largest proportion of maternal deaths in 2015 (201 000 deaths accounting for 66.3% of deaths globally[5]).

There are many causes of postpartum haemorrhage: atonic uterus, retained placenta, retained products of conception, uterine rupture, lower genital tract trauma, uterine inversion and consumptive coagulopathy. Atonic uterus is the most common cause of postpartum haemorrhage (PPH), and is responsible for about 80% of PPH cases. Ideally, prevention of PPH by avoiding prolonged labour and performing active management of the third stage of labour should be performed in order to reduce maternal deaths from PPH.

However, prompt treatment of PPH due to uterine atony is also very important. It can be initially managed by massaging the uterus, emptying the bladder and administering uterotonic agents. If bleeding continues and other causes have been excluded, operative measures such as the uterine compression suture (UCS), intrauterine balloon tamponade, uterine artery ligation and uterine artery embolisation can be used, followed by hysterectomy as a last resort.[6] Once medical management of PPH

fails, the abovementioned operative management, if instituted properly and in time, may be lifesaving. Unfortunately, in the most vulnerable group (pregnant women in developing countries), some of these options are not available because of lack of resources and expertise, in particular the skills for hysterectomy and resources for radiographic embolization

The B-Lynch suture was first developed by Christopher B-Lynch in 1997 as a conservative surgical management option that was easy to apply and required no special surgical training.[7] It was employed mostly for treating atonic uterus that does not respond to medical management.

Further modification of the B-Lynch-like Hayman suture has subsequently been developed, and these collectively are known as uterine compression sutures (UCSs). They have been used and reported on in many different centres in the world and have been shown to be very efficacious as a conservative surgical method for effectively managing PPH in many cases, without the need to resort to hysterectomy. It would therefore be relevant to audit the use of uterine compression sutures in an obstetric referral hospital in a low-resource setting and this is the aim of the proposed study.

2. LITERATURE REVIEW

2.1 B-LYNCH SUTURE

The original B-Lynch suture was first described by Christopher B-Lynch, a consultant in Obstetrics and Gynaecology at Milton Keynes General Hospital situated in Milton Keynes, Buckinghamshire, England, where he reported 5 cases of severe PPH collected during a 6-year period from 1989 to 1995. All 5 patients did not respond to initial medical management of PPH. Four of the 5 patients had primary PPH. The B-Lynch suture was successful in all 5 reported cases. Hysterectomy was not required and all 5 women survived. There were no reported complications following the procedure and, upon follow-up, 4 (80%) of the 5 patients conceived spontaneously. Two out of the 4 patients who conceived had caesarean sections, and examination of the uterus during the operation revealed a normal-looking uterus.

Christopher B-Lynch's original compression suture technique involved the following simple steps:

1. Position: Lloyd Davis supine position of the body with legs apart, hips and knees flexed for access to the vagina to assess the control of bleeding by swabbing the vagina intra-operatively.
2. Abdominal access through layers by Pfannenstiel incision, or the same incision is re-opened if PPH follows caesarean section delivery.
3. Lower segment incision on the uterus after bladder is bluntly dissected down or through the recent caesarean section incision to access the uterine cavity.
4. Uterine cavity evacuated and thoroughly examined for other causes of PPH such as tears and/or retained products of conception.
5. Uterus is then exteriorised and re-examined for any obvious bleeding points; otherwise, if bleeding is diffused such as in atonic uterus or coagulopathy, bimanual compression is tried to assess the potential chance of success of B-Lynch suture. The vagina is swabbed to confirm the control of bleeding from the bimanual compression test.

6. The procedure itself (Check figure 1), as quoted from the original B-Lynch article, involves placing

> ... absorbable suture 3 cm from the right lower edge of the uterine incision and 3 cm from the right lateral border. The suture is threaded through the uterine cavity to emerge at the upper incision margin 3 cm above and approximately 4 cm from the lateral border. The suture is now passed over to compress the uterine fundus approximately 3 to 4 cm from the right cornual border. The suture is pulled under moderate tension, assisted by manual compression exerted by an assistant. The length of the suture is passed back posteriorly through the same surface, marking as for the right side, the suture lying horizontally. The suture is fed through 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.[8]

7. The two lengths of suture are pulled taught, assisted by bi-manual compression to minimise trauma and to achieve compression.
8. During such compression, the vagina is checked to ensure that the bleeding is controlled.

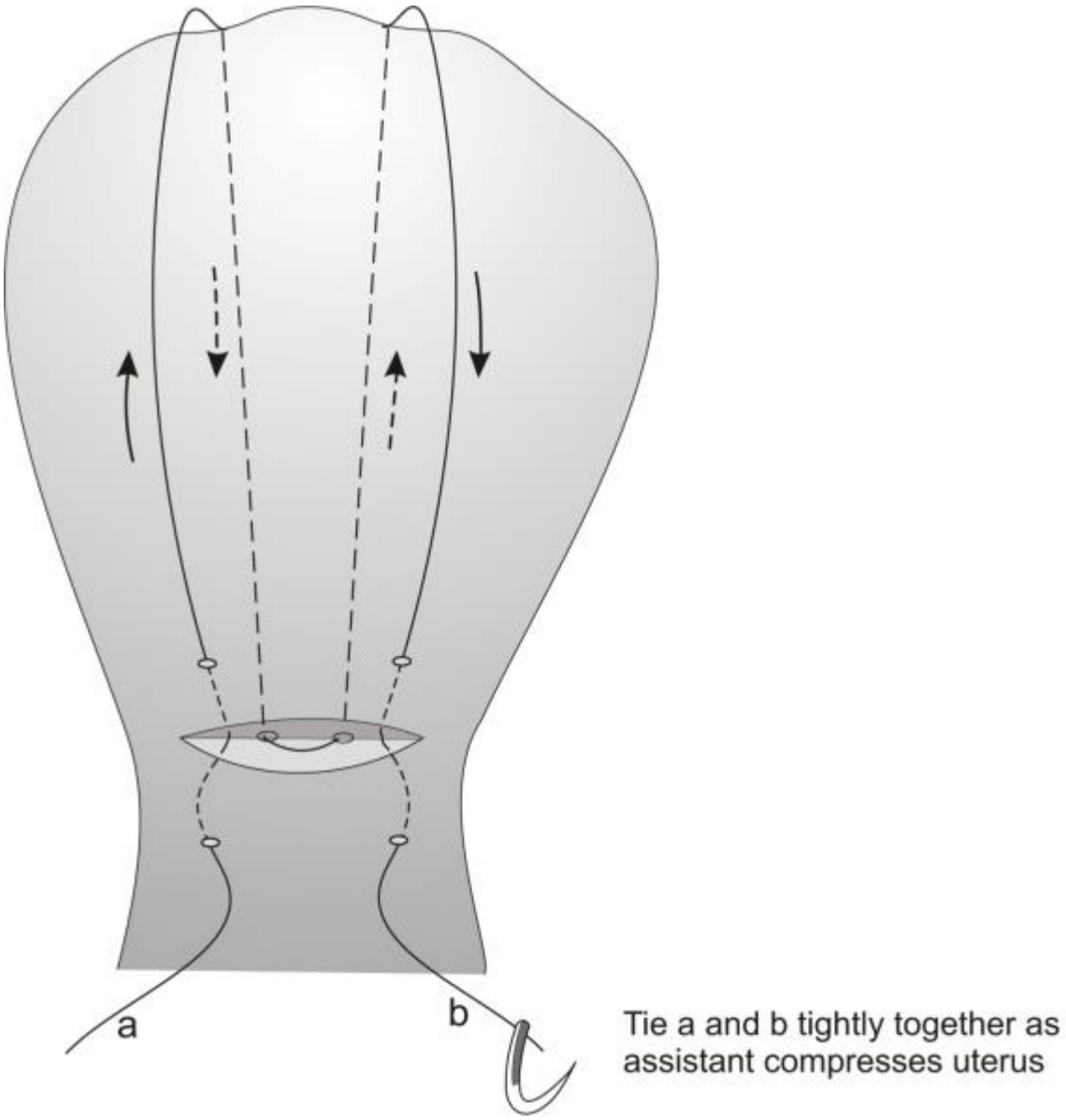

Figure1. *A picture of B Lynch suture technique adapted from: National Committee on Confidential Enquiries into Maternal Deaths. A Monograph of the Management of Postpartum Haemorrhage. Pretoria: National Department of Health. 2010.*[9]

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The advantages of the B-Lynch suture are as follows:

- Severe PPH can be stopped and potential maternal death can be avoided without the woman losing her uterus.
- Prior to performing the procedure, one can have a good indication of whether it will work or not by first doing a bimanual compression test; hence, if that specific test

fails, there may be no need to waste precious time on the procedure but rather proceed to additional surgical procedures such as stepwise uterine devascularisation or hysterectomy.

- The B-Lynch suture's effectiveness can be assessed immediately intra-operatively by swabbing the vagina. This is a big advantage in low-resource areas where theatre space, human resources and time are limited, and therefore patients should leave theatre with any bleeding problems having been optimally addressed, as there could be delays and technical difficulties if re-look laparotomy is required in such settings.

Accordingly, the B-Lynch suture is safe and easy to perform, requiring minimum training for management of PPH, and it also allows uterine preservation. Ideally, the patients so treated should be observed vigilantly in the first 12 hours post surgery to ensure no further bleeding owing to uterine atony.

There are limitations in the way this initial B-Lynch study can be interpreted. The study was of a small case series which is the second-lowest level of evidence. The patients in the study were all primigravidas with an average mean age of 27.6 years with no associated co-morbidities. Therefore, inferences of the B-Lynch success will not necessarily cover all women.

Since the initial B-Lynch study, there have been several case series of B-Lynch sutures described

In the year 2000, J E Ferguson and colleagues published a study with two cases where the B-Lynch suture was successfully used to treat severe PPH secondary to atonic uterus not responding to both medical management (uterotonics) and bilateral uterine artery ligation following caesarean section. The indications for caesarean section were for twins with abnormal presentation. The first case was preterm labour at 31 weeks with first twin footling breech and the second case was for retained second twin after the first twin spontaneously delivered. Postoperatively, one woman

did very well and was subsequently discharged after day 3 post caesarean section. The other patient was diagnosed with endometritis which responded to antibiotics and was subsequently discharged on day four post caesarean section. Hysterosalpingography was done on her follow-up date, four months after caesarean section, and showed no uterine defects and patent tubes. Magnetic resonance imaging (MRI) showed a normal uterine cavity and architecture.[10]

In the same year (2000), J V Dacus and colleagues also reported 100% success of the B-Lynch suture in a similar population group. Their conclusion was that they found the B-Lynch suture technically easy and it required less time to place, even though they conceded that at that stage the B-Lynch technique was in its infancy, with very few recorded successful cases.[11]

Subsequently, much interest in the B-Lynch was stimulated in many parts of the world, including beyond European countries. In 2003, a study from India published a case series of 6 primigravida patients who were treated with the B-Lynch suture for PPH (not responding to initial medical management) following emergency cesarean section. A 100% success rate was reported. Their conclusion was that the B-Lynch suture was an invaluable procedure for control of atonic primary haemorrhage following caesarean section. As India is a developing country with similar challenges to those in South Africa, it follows that this article is one of the few that is more relevant to our circumstances. [12]

In the same year (2003) another study by Smith and Basket from Canada was the first published study to report the first case of failed B-Lynch suture. They successfully applied the B-Lynch suture in 6 out of 7 cases with severe PPH not responding to initial medical management. In 3 out of 7 cases, the B-Lynch suture was actually applied after attempting other surgical management of PPH, including bilateral uterine and ovarian artery ligation and even other forms of compression suture such as the Cho square suture. The one case where the B-Lynch suture failed was possibly due to it having been performed for the wrong indication because it was applied in a patient with placenta praevia who developed disseminated intravascular coagulopathy and subsequently required a hysterectomy.[13]

Following the Smith and Basket study in 2005, another study reported a 91% success rate of the B-Lynch suture applied in 11 patients who had severe PPH not responding to initial medical management following caesarean section. All cases except one had emergency caesarean section. The only elective caesarean section was for placenta praevia major. Only one out of the 11 cases resulted in hysterectomy. Follow-up of all patients was uneventful and, of those 10 patients for whom the uterus was preserved, 2 women conceived spontaneously with intrauterine pregnancies while the other patients (except the only woman who had hysterectomy) did not wish to fall pregnant at the time of follow-up. The article suggested that, since the B-Lynch suture can be used safely and effectively, this technique should be included in the training programmes for junior obstetrics staff.[14]

In the same year (2005), E El Hamamy and C B-Lynch carried out an extensive worldwide review of the use of the UCS technique as an alternative to hysterectomy in the management of severe PPH. They assessed more than 10 published papers reporting more than 46 cases. In almost all cases reviewed, a 100% success rate of compression sutures was reported, except in one (that of Smith and Basket described above who had 6 successes in 7 cases).

E El Hamamy and C B-Lynch recommend the use of compression sutures before more radical surgery is undertaken. In their assessment of the available evidence, they suggested that, medico-legally, it may become substandard to resort to hysterectomy without having tried the compression suture technique as an initial surgical measure[8].

The Royal College of Obstetrics and Gynaecology (RCOG) Green-top Guidelines 52 (Postpartum haemorrhage, prevention and management) also recommend that, in every theatre performing caesarean section, there must be a laminated diagram of the UCS technique.[15]

In 2009, E Koh and colleagues also reported a 71% success rate of the B-Lynch suture. They successfully used UCSs in 5 out of 7 cases of PPH not responding to medical management.

In the first case of the two failed cases, a modified B-Lynch suture was performed in which the uterine incision was not reopened (Hayman technique) but failed to stop the bleeding, hence resulting in hysterectomy. The second failed case involved bleeding largely owing to a cervical tear in addition to uterine atony which also resulted in hysterectomy. All patients except one, who had cardiomyopathy and pulmonary embolism, were reported to have had an uneventful postoperative recovery. They concluded that the B-Lynch suture was an effective method in containing PPH. It is easy and fast to apply and should be taught to all trainees and all registrars in obstetrics.[16]

2.2 MODIFICATION OF THE B-LYNCH SUTURE

Following Christopher B-Lynch's article in 1997, there have been moves to develop simpler ways to perform uterine compression sutures, particularly for an unscarred uterus (i.e. atonic uterus following vaginal delivery rather than at caesarean section.

R G Hayman in 2002 described a modification of the B-Lynch which was successfully applied in three patients with life-threatening severe PPH secondary to atonic uterus not responding to conservative management. Hayman's main aim was to make the technique less complex than the original B-Lynch. Hayman's technique is very similar to the B-Lynch suture (see figure 3), the only big 'trade-mark' difference being that, in the Hayman suture, if the PPH follows the vaginal delivery, the procedure is done without opening up the uterus. The other minute difference is the optional placement of an isthmic-cervical compression suture which is first inserted to control bleeding from the cervix and lower segment. This isthmic-cervical compression suture, which is optional and not usually incorporated when performing the Hayman suture technique in our setting, has now become a precursor of a new innovative method for conservative treatment of morbidly adherent placenta. The advantage of this technique over the original B-Lynch is that it does not necessitate hysterotomy, and hence it should be technically quicker and avoid scarring the uterus, which then avoids a potential risk factor for future pregnancies. The disadvantage is that the surgeon is unable to adequately assess the uterine cavity for local bleeders or expelled blood clots which can have an effect on the success of the technique. Another potential

complication is the impairment of blood drainage by the isthmic-cervical compression suture by unavoidably closing the cervical os; the authors therefore recommend that, if an ischaemic-cervical suture is applied, a pair of closed artery forceps be placed between the medial margins of the two isthmic-cervical compression sutures to ensure that the cervical canal remains open. [17]

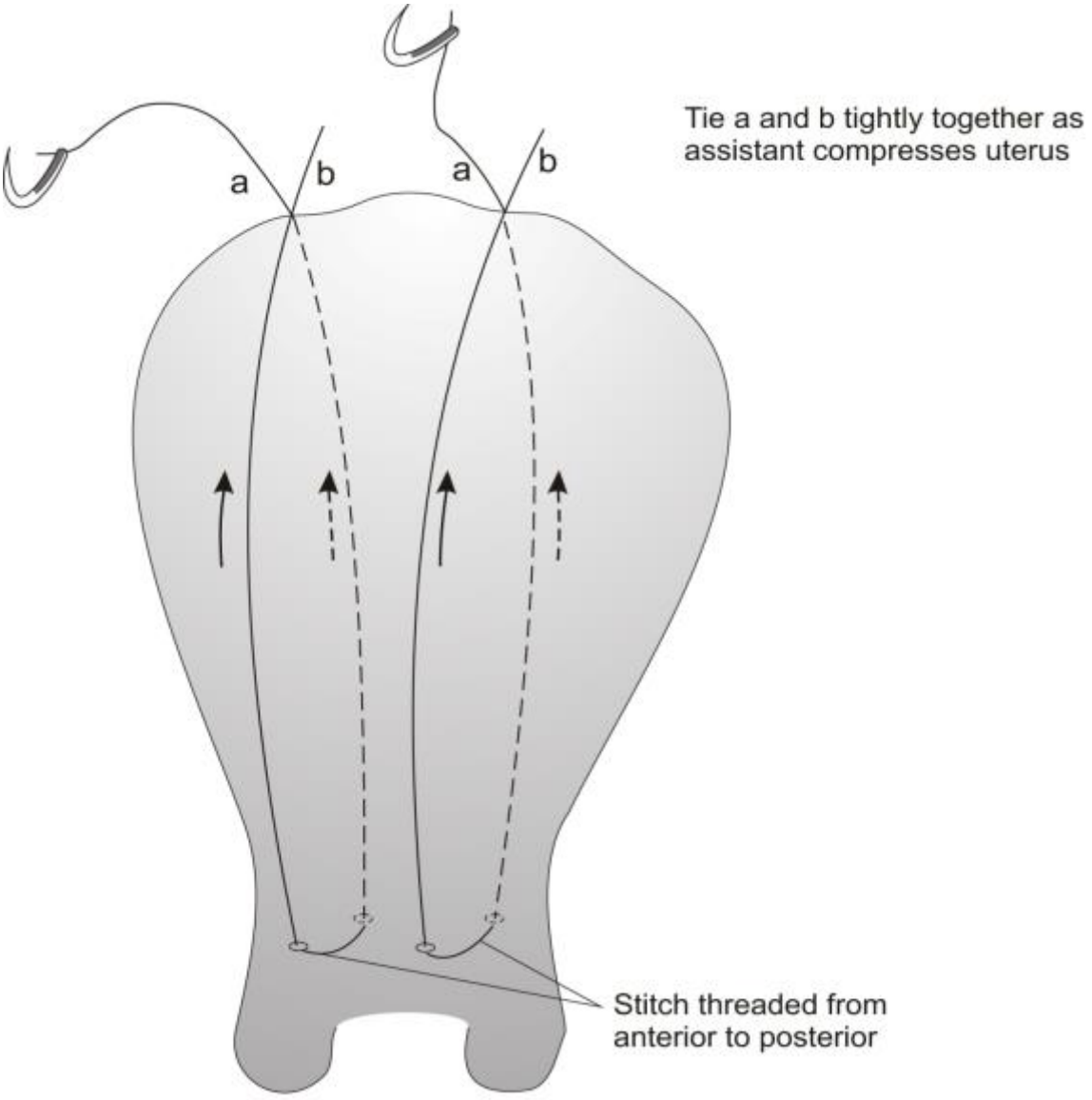


Figure 3. *A picture of Hyman compression suture adapted from: National Committee on Confidential Enquiries into Maternal Deaths. A Monograph of the Management of Postpartum Haemorrhage. Pretoria: National Department of Health. 2010.* [9]

Prior to the Hayman suture, J H Cho devised a modified version of the original B-Lynch suture in 2000. He described the purpose of his technique as to approximate the anterior and posterior uterine walls until no space is left in the uterine cavity. Thus, bleeding from the endometrium because of uterine atony or placenta site bleeding can be controlled by compression. In Cho's technique, 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. If bleeding is caused by uterine atony, four to five square sutures (the same as described above) are placed evenly throughout the uterus from fundus to the lower segment (see figure 4). If bleeding is due to placenta accreta, with bleeding in the placental separation site, the sutures are focused in two to three areas of heavy bleeding. Cho's technique only concentrates on selected areas of heavy bleeding because it is believed that, if the procedure included the entire cavity, blood drainage might be compromised and compression diminished.

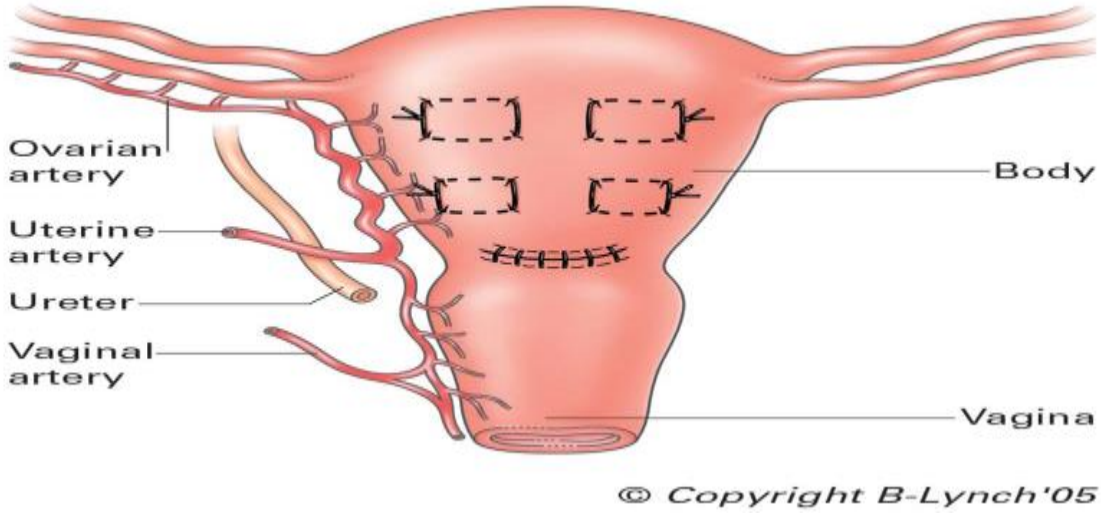


Figure 4. A picture representing Cho 's technique adapted from: Cho JH, Jun HS, Lee CN. Hemostatic suturing technique for uterine bleeding during caesarean delivery. Obstetrics and Gynecology. 2000; 96:129-131.[18]

Cho used this technique in 23 women (during the two-year period 1996 to 1998) with PPH at caesarean section who did not respond to conservative management. In all cases, bleeding was stopped and hysterectomy was avoided. All 23 women resumed normal menstruation and 4 out of 10 of the women who desired fertility successfully became pregnant again after Cho's technique was performed.[18]

In an effort to address potential complications such as endometritis which may arise from compression uterine sutures penetrating the endometrial cavity as described with the original B-Lynch suture, Cho's technique and Hayman's suture described above, Alcides Pereira devised another modification of the B-Lynch suture in 2005 which also achieved a 100% success rate and was demonstrated to be safe and did not affect menstruation nor fertility on follow-up. The main difference with the above-described compression suture is that Pereira 's technique involves a series of transverse and longitudinal sutures inserted superficially, taking only the serous membrane and the subserous myometrium without penetrating the uterine cavity (see figure 5). The author reports that the average time to perform the procedure is 5 minutes. According to Pereira et al., other than being a quick technique to perform, the small size of the superficial bites applied to the uterus reduces the risk of a loop of bowel or omentum coming between the uterus and the suture with puerperal uterine involution. Also, the combination of longitudinal and transverse sutures not only aids compression but also collapses the lumen of ascending branches of the uterine artery, reducing vascular flow and venous bleeding.[19]

Figure 5. A picture representing Alcides Pereira ‘s technique adapted from: Pereira A, Nunes F, Pedroso S, Saraiva J, Retto H, Meirinho M. Compressive uterine sutures to treat postpartum bleeding secondary to uterine atony. Obstetrics & Gynecology. 2005;106(3):569-72.[19]

There has been a technical concern with a potential complication of the original B-Lynch suture, being what happens when involution of the uterus occurs, as described above by Pereira. The sutures could entangle the adjacent structures including the bowel, causing ischaemia and necrosis. Others described the potential arms of the original B-Lynch sutures sliding off the fundus as a result, affecting its effectiveness. Hence, Jeevan Prasanga Marasinhe and colleagues modified the B-Lynch in 2009 in an effort to address those potential aspects, yet keeping it simple and effective. Their technique differs from the rest in that the suture is anchored at the fundus, which avoids the potential sliding of the suture from the fundus when the uterus is involuted. Thus it has the potential advantage of preventing the suture from entangling the adjacent structures such as the bowel, causing ischaemia and necrosis. This technique successfully prevented hysterectomy in the two cases reported in Marasinhe's article about PPH secondary to atonic uterus; follow-up was recorded as uneventful. [20]

In 2010, a study by J Zheng described a modification of the B-Lynch suture combining previously described modifications of the B-Lynch in order to address the known complications of applying the original B-Lynch suture:[20]

1. To avoid the potential complications encountered with many other described compressive uterine sutures, such as pyometrium, uterine synechiae and uterine necrosis attributed to puncturing the uterine walls and directly suturing the anterior and posterior uterine walls together, obliterating the cavity, with Zheng's technique (the same as that of Alcides Pereira when performing a UCS) the needle is not allowed to completely penetrate the entire thickness of the wall and enter the uterine cavity.
2. Emergency hysterotomy is not necessary, just as in the Hayman suture in a case of PPH following vaginal delivery requiring UCS.
3. The UCS is anchored at the uterine fundus, similar to Marasinghe's procedure, which eliminates the risk of sutures sliding off at the uterine fundus with the potential of entangling adjacent structures, such as the bowel, when the uterus completely involutes in a few days post delivery.

4. Zheng's technique uses synthetic absorbable sutures instead of delayed absorbable sutures, which avoids suture erosion or the suture protruding from the uterine cervical os several weeks after the procedure has been performed, which is a known complication in other UCS techniques. [21]

In Egypt, another modified version of the B-Lynch suture was published by Abdel-Aziz El-Refaeey and colleagues in February 2014, in a quest to address several perceived drawbacks of the original B-Lynch. The drawbacks were identified as follows:

1. In the original B-Lynch, there are several uterine wall punctures or bites (six in total) which have the potential of bleeding.
2. The middle portion of the uterus may still bleed following application of the sutures.
3. The potential risk of occlusion of the uterine cavity and blood entrapment because the uterus has to be transfixed from front to back in order to place the suture.

El-Refaeey's technique involves only two punctures through the uterus from the anterior wall through the cavity to the posterior wall on both sides, 2 cm below the hysterotomy incision and 3 cm from the lateral uterine border, on both sides dividing the suture into two equal halves, making a V appearance when tying the loose part of the suture at the fundus. Both apexes of the V-form sutures are below the hysterotomy incision where the uterus is punctured on both sides (See figure 6). Other than less punctures on the uterus, the other distinguishing feature of the VV compression suture is that there is no need to re-open the uterine incision as in the Hayman suture compared with the original B-Lynch suture.[22]

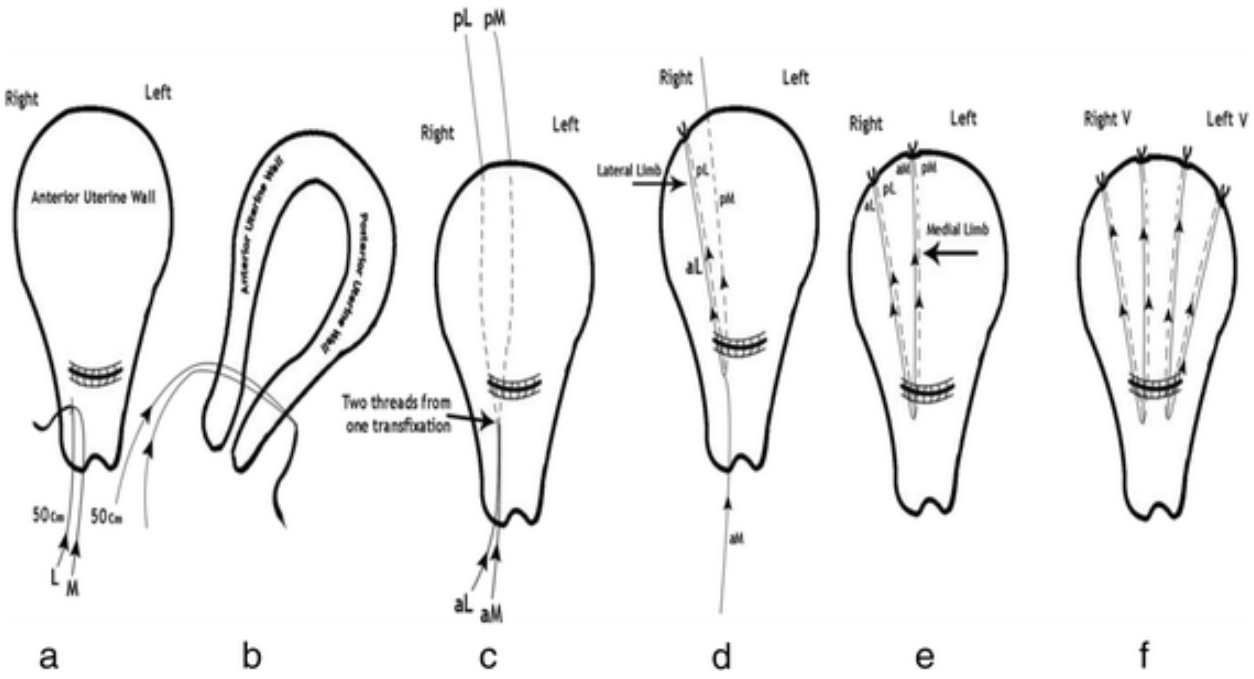


Figure 6. A picture of VV compression suture: Matsubara S. Some clarification and concerns regarding a novel VV uterine compression suture. Journal of Obstetrics and Gynaecology Research. 2014 Apr 1;40(4):1165-6. [23]

The most recent study on the modification to the B-Lynch suture was published in November 2014 by Abderrahim Aboulfalah and colleagues from Morocco. This is the first removable UCS described in the literature. Aboulfalah reports that the most frequent complication of a typical UCS is uterine synechia which accounts for 18%–54% of known complications and inevitably compromises fertility. Accordingly, Aboulfalah's new modification of the B-Lynch provides the same effect of uterine compression but prevents the risk of uterine synechia formation by using a removable suture that can be taken out 24–48 hours after the procedure. (It is known that inflammation around sutures and infection is responsible for synechia.) Hence in this technique, the suture is removed after 24–48 hours so as to avoid or minimise the process of inflammation and infection and thus avoid synechia. [24]

Since 1997, several modifications of the B-Lynch suture have been published and reported to have 80%–100% success rates, with a minimum of documented side-

effects or adverse sequelae for future pregnancies. All studies about modifications of the B-Lynch suffer the same criticisms of small sample size and no randomised trials (only case studies). However, none of them has shown results superior to those described by B-Lynch. The classic B-Lynch suture technique has remained the standard uterine compression suture because other modifications have yet to be validated. As a result, it is advisable that those who perform caesareans must choose to learn how to perform one compression suture technique which they should become experienced in.

2.3 COMBINATION OF B-LYNCH SUTURE AND OTHER TREATMENT MODALITIES

The UCS has been generally proven to work in 85% of PPH cases secondary to atonic uterus. As PPH can also be caused by numerous factors, the use of the UCS together with another form of treatment may be considered. The first report on the use of the UCS and intrauterine balloon catheter was reported in 2002. It was a case report of a 38-year-old primigravida who was admitted post term for routine induction of labour (IOL) after an uneventful antenatal course. After three days of IOL with different agents, a caesarean section was performed for failed IOL. Atonic uterus developed during caesarean section which was managed medically first by oxytocics with no success. A B-Lynch compression suture was used and partially succeeded but the patient still continued to bleed. An intrauterine balloon catheter was then used in combination with B-Lynch suture which successfully stopped the bleeding. The intrauterine balloon catheter was removed 48 hours later. The author reports that an additional advantage of this combined procedure is that the volume of blood draining into the intrauterine balloon catheter bag can be measured. The combination of UCS and intrauterine balloon catheter is known as the uterine sandwich technique.[25]

Another use of a combined method was described by Ahmed Y. Shahin and colleagues in 2009. The aim of their study was to evaluate the effectiveness of bilateral uterine artery ligation (UAL) followed by B-Lynch compression suturing in controlling postpartum haemorrhage in women in whom complete removal of a

placenta accreta was not possible and there was also atonic uterus. There were 26 women eligible for the study, including women who were diagnosed with placenta accreta prior to delivery and intraoperatively had difficulties in delivering the placenta. The placenta was delivered in small pieces with placental remnants left in situ, with resulting PPH from the placental site in combination with reported atonic uterus. As a result, the PPH was from both atonic uterus and bleeding from the placental site. Of these 26 patients, 2 died from disseminated intravascular coagulopathy. The combined method of bilateral UAL and B-Lynch compression suture was used and successfully stopped the PPH in the surviving 24 patients, with no need for hysterectomy. Follow-up of these 24 women showed encouraging results for this combined method. Normal menstruation resumed within 3 months in 20 patients (83.3%), and none experienced irregular bleeding. After 1 year, 18 (75%) of the 24 patients became pregnant and, of the 6 patients who did not become pregnant, 4 were using contraceptives. The other 2 patients were diagnosed with secondary infertility owing to other causes not related to the procedure e.g. one had galactorrhea, diagnosed as having hyperprolactinemia at an infertility clinic. The author concedes that even though the procedure had shown great success and no impact on fertility, hysterectomy should be first considered in patients who have no desire for fertility and in patients with PPH where complete removal of a placenta accreta is not possible.[26] Although the combination technique as described above seems to yield good results, a concern is the sample size from which the conclusion was extrapolated; hence, further studies are needed before this method can be widely recommended for use in the future.

2.4 USE OF COMPRESSION SUTURE IN PATIENTS WITH PLACENTA PRAEVIA

The original compression suture described by B-Lynch et al. in 1997 was primarily intended for uterine atony. The use of the compressive uterine suture in placenta praevia for controlling bleeding in the lower uterine segment was first described as putting a figure-of-eight suture in the lower uterine segment by Hwu et al.[27] and Hayman.[14] A study by Hao Ying and colleagues In 2010 described a retrospective study which aimed to evaluate the efficacy of transverse annular compression sutures

in achieving haemostasis after traditional conservative methods had failed to control bleeding during cesarean delivery in women with complete placenta praevia. A total of 41 pregnant women with complete placenta praevia were included in the study. There were two inclusion criteria:

1. Persistent bleeding from the separated placental surface of the lower uterine segment at cesarean delivery after successive use of uterotonics, local suturing, and/or ligation of uterine arteries.
2. Subsequent administration of either uterine packing (UP) or transcerse annular compression sutures.

Transvers annular compression suture is a simple single stitch described as:

> A 70-mm curved round needle is placed at about 2–4 cm from the right lower edge of the uterine incision and about 1 cm from the right lateral border of the lower segment of the uterus. The needle is passed from the anterior to the posterior wall. The suture is pulled left horizontally. The needle is then passed from the posterior to the anterior wall at the same level as the right posterior exit point. The knot is tightened .[24] (see figure 7)

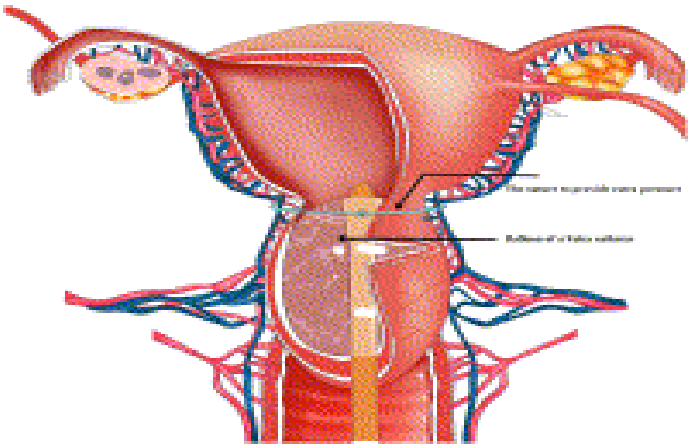


Figure 7. A picture of Transvers annular compression suture: Ying H, Duan T, Bao YR, Song YH, Wang DF. Transverse annular compression sutures in the lower uterine segment to control postpartum hemorrhage at cesarean delivery for complete placenta previa. International Journal of Gynecology & Obstetrics. 2010;108(3):247-8.[28]

There were 24 patients in the UP group and 17 patients in the Transvers annular compression suture group. There was no significant difference at baseline in age, body mass index gravidity, parity, gestational age at delivery, birth weight, doses of uterotonics, and incidence of placenta accreta. Overall, there was greater blood loss throughout the caesarean delivery procedure in the UP group compared with the Transvers annular compression suture group, and also the quantity of blood transfused was also significantly higher in the UP group than in the Transvers annular compression suture group. The reason for this difference was partly attributed by the author to greater blood loss which was related to the longer time taken to complete the intervention, as it took more time to perform UP than to perform Transvers annular compression suture. Hysterectomy was unavoidable in 2 (8.3%) patients in the UP group because of intractable bleeding. Transvers annular compression suture failed to stop bleeding in only 1 (5.9%) patient in the Transvers annular compression suture group. The success rates (i.e. achievement of haemostasis) were 91.7% and 94.1% for UP and Transvers annular compression suture, respectively.[28]

The other new compressive suture method found to be effective for complete placenta praevia (CCP) with or without placenta accreta was described by Lei Zhu et al. in 2014.[29] The idea of this modification suture for placenta praevia is reported to have originated in an attempt to solve problems pertaining to the fact that, even though UCSs which include B-Lynch, Pereira, Cho square or Hayman have been shown to markedly decrease maternal mortality associated with PPH, these methods did not appear to always stop bleeding within the less contractile area of the uterus – the lower uterine segment. Hence, specialised sutures addressing bleeding from the lower segment were invented, including the transverse annular compression described above and Lei Zhu's technique called the Lu suture. The Lu suture is basically insertion of a balloon catheter in the uterus at the area where there is bleeding (lower segment) together with insertion of an absorbable suture through both sides of the avascular zone below the origin of the round ligament from the uterus. This suture is located close to the fold of the peritoneum, according to the haemorrhage site of the uterus and the size of the balloon. After the suture is tied, it provides extra pressure to

ensure that the balloon has tightly compressed the haemorrhage site, while concurrently blocking the branches of the uterine artery. The balloon remains in place for 24 hours[27]. To prove the effectiveness of this modification of the balloon catheter for placenta praevia, Le Zhui et al. performed an observational study conducted at Beijing Chaoyang Hospital in Beijing, China, among patients with complete placenta praevia (with or without placenta accreta) who were enrolled from 1 January to 31 March 2014. Seven women who were considered eligible for the Lu suture had heavy bleeding from the lower uterine section while the body of the uterus contracted well without haemorrhage. Five of the 7 women underwent elective caesarean section at term. The remaining 2 women had caesarean section before term, one because of complications of pre-eclampsia (went into heart failure) and the other because of antepartum haemorrhage. Six participants had previously undergone uterine surgery. Two of the deliveries were complicated by placenta accreta. The Lu suture was successful in stopping the bleeding in all 7 patients with complete placenta praevia, and none of the women had delayed haemorrhage that required relook laparotomy or hysterectomy. The author concluded that the Lu suture technique provided an easy and efficient surgical choice for women with CPP, especially among those with placenta accreta. The author also noted that the Lu suture is not suitable for all patients with complete placenta praevia, e.g. if there were ongoing haemorrhage of the body section of the uterus, or if the cervix were too loose to hold the Foley catheter balloon when filled with 120 ml of water.[25] This observational study, like almost all the compression uterine suture studies, suffers the similar criticism of a small population from which to draw a firm conclusion about the suture's efficacy and, being a new approach, there is no long-term follow-up available to measure its safety and to compare it with other alternatives for managing patients with complete placenta praevia.

2.5 USE OF B-LYNCH SUTURE AS PROPHYLAXIS WHEN ANTICIPATING PPH

In 2002, one study described a case report where the B-Lynch suture was performed prophylactically in a woman considered at high risk for postpartum haemorrhage while performing an elective caesarean section at a gestational age of 33 weeks. The patient was a

31-year-old white woman with triplets. She was a Jehovah's Witness and, for religious reasons, had declined any form of blood transfusion. It was also reported that the patient's booking haemoglobin had dropped from 12.6 g/dL to 11.1 g/dL despite antenatal iron supplements; antenatally she had received erythropoietin. Intra-operatively she was given uterotonics and a prophylactic B-Lynch was performed. The caesarean section was uneventful with minimal estimated blood loss. Postpartum haemorrhage and caesarean hysterectomy was avoided.[30] Since that single case there has not been any other reported literature specifically for use of B Lynch suture as a prophylaxis when anticipating PPH.

2.6 COMPLICATIONS OF UCS

Different studies have been conducted to address the possible complications and their prevalence following UCS application; however, in all these studies, a common challenge was limited data and, in some UCS studies, the absence of long-term complications owing to the short duration of the follow-up.

Channamallikarjuna and El-Hamamy performed a literature review in 2009; their main focus was to investigate various uterine compression techniques with respect to their efficacy, safety, complications, complexity of the technique itself, future fertility and menstrual periods. [31] They narrowed down their focus to eight selected different types of UCS which included the B-Lynch, Cho, Hayman and Pereira types. Channamallikarjuna's review concluded that, in addition to being a lifesaving procedure and having the capacity of preserving the uterus and thus fertility, the original B-Lynch suture technique offers the advantage of being able to confirm uterine cavity emptiness, satisfactory haemostasis can be ensured soon after application, and it avoids obliteration of cervical and uterine lumen. There is reduced risk of pyometra and synechiae with the original B-Lynch suture as compared with various other modified uterine compressive techniques such as the Cho. No serious complications have been reported with the B-Lynch technique. Hayman's technique is faster to perform as the uterine cavity is not explored under direct vision, but morbidity data and future fertility are not known.

Joshi and Shrivastava published a case report in 2004 of a 26-year-old primiparous woman who had partial ischaemic necrosis of the uterus following a B-Lynch suture, 12 hours after an emergency caesarean section complicated by PPH secondary to atonic uterus.[32]

A similar case report by A G Gottlieb et al. in 2008 recorded uterine necrosis 8 days post caesarean section and B-Lynch suture for emergency caesarean section complicated by PPH secondary to atonic uterus.[33]

Another study published a case report of a young woman who presented after 4 weeks with pyometra after being managed with UCS (Cho technique) following emergency caesarean section complicated by PPH secondary to atonic uterus. It was reported that this patient had a successful Cho technique UCS at caesarean section after a failed attempt of uterine artery and utero-ovarian artery ligation. The patient recovered quickly and was discharged on day 4 post caesarean section. She presented 4 weeks postpartum with puerperal sepsis and pyometra. The patient was managed with ultrasound guided dilation and curettage where loculations were broken up with expulsion of mucopurulent material. Intravenous antibiotics were administered and she was discharged 2 days later after evacuation, afebrile and pain free.[34]

3. RESEARCH DESIGN AND METHODS

3.1 Overview

My aim in the present study was to assess how the proven, effective technique of the UCS is utilised in our setting (secondary hospital in a developing country) so as to identify any areas or gaps needing improvement which could be unique to our environment and circumstances. Such a study has not previously been conducted in Africa and would help to improve the management of patients with PPH in our institution and those in similar institutions in developing countries that share the same common burdens of diseases such as HIV/AIDS, and under-resourced and under-staffed healthcare. At Mowbray Maternity Hospital (MMH) in particular, we have noticed a sharp increase in the use of the UCS (especially the B-Lynch and Hayman techniques) since we started keeping clear records of its use in theatre since 2010. There has never been an audit of its use at MMH nor in the whole of Western Cape Province, and it would be most interesting to investigate (1) how often the technique is performed, (2) under what circumstances it is performed, (3) by what level of surgeon it is applied, (4) the success rate and (5) how often it is used in combination with another treatment modality such as balloon catheter.

3.2 Aims and objectives

3.2.1 Overall aim

To review the use of the UCS for management of PPH at MMH.

3.2.2 Specific objectives

- To measure the number of women for whom UCSs were inserted from 2010 to 2016.
- To describe demographic, obstetric and surgical factors associated with the use of UCSs.
- To describe the short-term maternal outcomes associated with the use of UCSs.

3.3 Study design

This was a retrospective observational study conducted at MMH from January 2010 to June 2016.

3.4 Study population

All women who received management for primary PPH at MMH during the period between January 2010 and June 2016.

3.5 Inclusion criteria

Study subjects comprised all women who had UCSs inserted at MMH for uterine atony not responding to medical management during the period between January 2010 and June 2016. Several methods were used to identify study subjects. They were identified from the theatre register, which has a full description of all surgical procedures performed in theatre from 2010 to 2016. Cases were also identified for which there was documented insertion of UCSs in the theatre register. In addition, all patients were identified from the same register which were recorded as having had severe blood loss (>1500 ml) and those who had a laparotomy for PPH following vaginal delivery, or a re-look laparotomy or hysterectomy. Such patients might have had a UCS which was not recorded in the theatre register, especially if it failed to arrest the haemorrhage. There is also a separate register (B Lynch book) in the MMH theatre which contains records of B-Lynch UCSs performed from 2010 to date.

3.6 Data collection

Folders of all the above identified cases were retrieved in order to identify all women who had a UCS. The folders retrieved were examined to extract demographic, clinical and outcome data. Success of the procedure was described as cessation of bleeding with no need for hysterectomy and no mortality. Failure of the compression suture in the present study was defined as patients with PPH managed with a compression suture who required hysterectomy owing to ongoing bleeding or who died. A purpose-designed data collection sheet was used to collect the necessary data (Appendix 1).

3.7 Sample size

Collection of 7 years of data was estimated to give a total sample size of 100, based on an estimated UCS use of 2–3 per month. This number was thought to be a sufficient sample from which to draw inferences about the use of UCSs. The sample size was higher than other published series.

This was a descriptive study and the findings of the study are presented as descriptive data mainly using tables and graphs. Categorical variables were analyzed using chi-square tests to assess the differences between groups. Differences in continuous variables between the groups were analyzed using a t-test. A significance level of $p<0.05$ was used as the cut-off for statistically significant differences between the groups for all statistical tests.

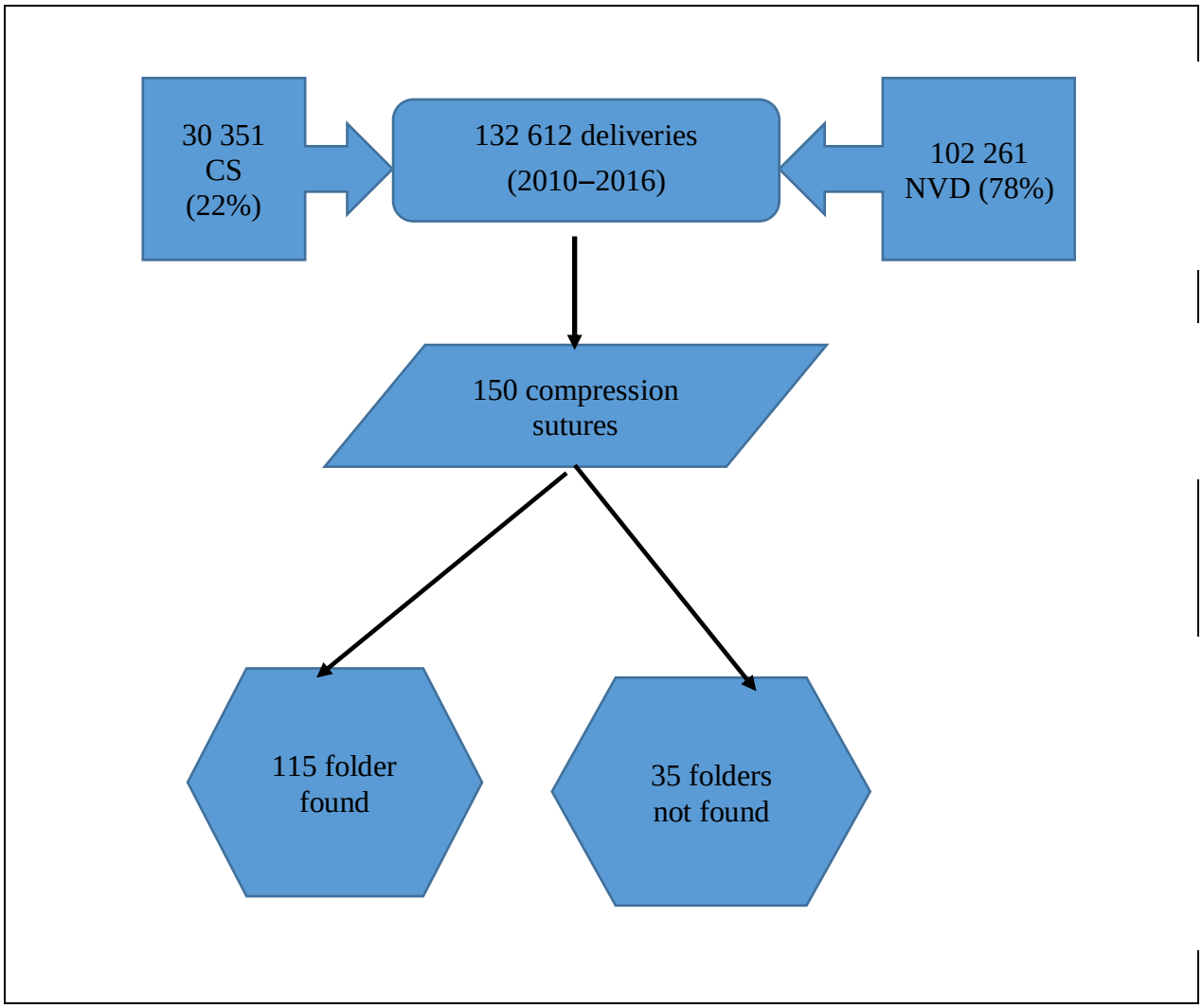
3.8 ETHICAL ISSUES

Ethical approval for conducting the study was obtained from UCT's HREC. All data were kept anonymous and confidential. As this was a retrospective folder review, individual patient consent was not required. The research was conducted in accordance with the principles of the Helsinki Declaration.[35]

4. RESULTS

Between January 2010 and June 2016, there was a total number of 132 612 deliveries at MMH and its referring midwife obstetric units (MOUs). Most of the patients (102 261 (78%) delivered normally whilst 30 351(22%) delivered by caesarean section. A total number of 150 cases of compression suture were identified over the study period (January 2010 – June 2016). A total of 115 folders (77%) out of 150 identified cases were found (Figure 1). The 35 missing folders could have been misplaced in MMH or in GSH if they had been transferred.

Figure 8: Total number of deliveries, MOD and total UCSs over the study period.



4.1 Incidence of UCS

The overall incidence of UCS was 0.87/1000 deliveries, with 3.52 cases of UCS per 1000 caesarean sections as opposed to 0.08 cases of UCS per 1000 normal vaginal deliveries.

Table 1 shows the numbers and incidence of UCS in a year-by-year breakdown over the study period.

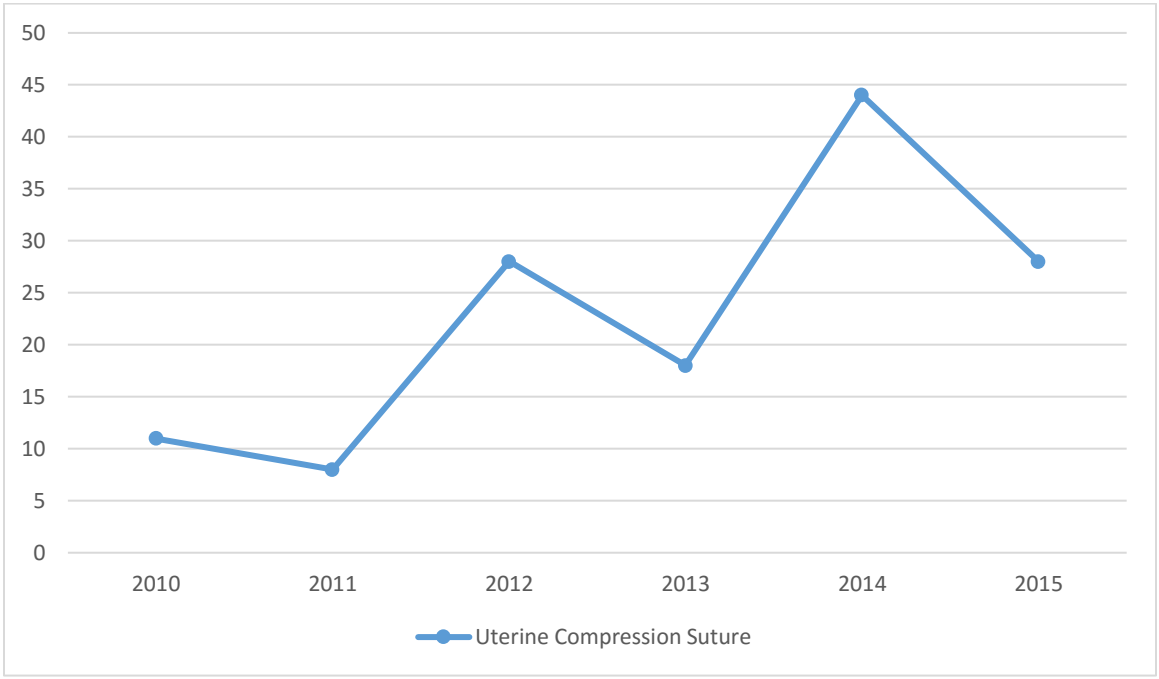
Table 1: Incidence (number UCS per 1000 deliveries) of UCS per year over study period.

Year	Deliveries*	Number of UCSs	Incidence UCS
2010	21 763	11	0.5
2011	22 235	8	0.4
2012	20 907	28	1.3
2013	20 722	18	0.9
2014	19 333	44	2.3
2015	18 669	28	1.5
2016 (Jan–June)	8 983	13	1.4

**Deliveries include MMH deliveries PLUS deliveries at MOUs that refer to MMH*

Table one shows that, over 7 years, there has been an overall increase in the rate of use of UCSs at MMH with a maximum in 2014,
The numbers of UCS performed per year at MMH (2010 to 2015) is illustrated graphically in Figure 2. 2016 figures are not included because they were only for half of the year.

Figure 9: Numbers of UCS per year during the study period.



4.2 Patient demographics

Table 2 shows the demographics of patients who had UCS. The patients' ages ranged from 15 to 45 years of age with a mean age of 27.54 (SD±6.62). The average gravidity and parity were 2 and 1 respectively, whereas the average gestational age at delivery was 38.33 weeks (SD 3.07). The minimum pre-delivery haemoglobin was 5,5 g/dl with a maximum body mass index of 28.78 kg/m². The HIV prevalence of the study group was 17%.

Table 2: Patient demographics (n=115).

	Mean	Maximum	Minimum	SD
Age (yrs)	27.54	45	15	6.62
Gravidity	2.37	8	1	1.53
Parity	1,21	6	0	1.39
GA at delivery (wks)	38.33	43	27	3.07
Booking Hb (g/dl)	11.02	14.4	6.8	2.12
Pre-delivery Hb	10.89	14	5.5	2.32
BMI (kg/m^2)	28.78	46.1	19	9.57
HIV status	Reactive (20/115) 17%	Non-reactive (95/115) 83%		

The two most common associated factors seen in the study population were the presence of pre-eclampsia and previous caesarean section, which was found in 27.83% and 24.35% respectively of the total number of patient who had UCS. The other factors found in women who had UCS insertion were malpresentation (9.57%) and abruptio placentae (8.70%). Multiple gestation, gestational aproteinuric hypertension and prolonged rupture of membranes (i.e. rupture of membrane more than 24 hours) were each found in 7.83% of the patients who had UCS. There were 4 patients (3.48%) who had no significant past obstetrics history, 2 patients (1.74%) had placenta praevia and only 1 patient (0.87%) had a multifibroid uterus. (check Table 3 below).

Table 3: **Obstetric history.**

Obstetric history	**Number (*N*=115)**	**Percentage (%)**
MFU	1	0.87
Placenta praevia	2	1.74
Prolonged ROM	9	7.83
Gestational HPT	9	7.83
Multiple gestation	9	7.83
Abruptio placentae	10	8.70
Malpresentation	11	9.57
Previous CS	28	24.35
GPH	32	27.83
No significant past obstetrics history	4	3.48

4.3 **Intrapartum data**

Of the 115 patients who had UCS, 88 (76.5%) were in labour prior to UCS application and the remaining 27 patients (23.5%) were never in labour. Among the 88 patients who were in labour, 23 patients were induced and 65 patients had spontaneous labour. Of those who were in labour, 38.7% had prolonged labour which was defined as the active phase of labour lasting more than 10 hours and/or total labour lasting more than 18 hours, and 23.9% patients received augmentation of labour with oxytocin. Regarding MOD, only 8 (7.0%) out of 115 patients who had UCS delivered vaginally while 107 (93.0%) patients delivered by caesarean section. Of the patients who delivered by caesarean section, the majority (94.3%) were emergency caesarean sections (Table 4A and 4B).

Table 4 A: Intrapartum data (*N* = 115).

Labour	**N**	**%**
No	27	23.5
Yes	88	76.5
MOD		
CS	107	93.0
Emergency CS	101	94.3
Elective CS	6	5.7
NVD	8	7.0

Table 4 B: Intrapartum data (i.e. Patients in labour) (*N* = 88).

Induction of labour	N	%
No	65	73.9
Yes	23	26.15
Prolonged labour		
No	54	61.3
Yes	34	38.7
Augmentation of labour		
No	67	76.1
Yes	21	23.9

4.4 Operative data

The majority (63.4%) of the patients who had UCS were operated on by registrars, followed by consultants and medical officers equally at 18.3%. Regarding anaesthesia, 60% of the patients who underwent caesarean section and required UCS had regional anaesthesia and 40% (including patients who UCS following normal vaginal delivery) had general anaesthesia. Forty-four of the 115 patients who had UCS had an additional procedure done, and 50% of the patients who required an additional procedure had uterine tear repair, whereas 36% had a sandwich (UCS and balloon tamponade). Of the remaining patients who had additional procedures, 11.4% had

evacuation of the uterus and 2.2% had uterine artery ligation. Regarding timing of UCS insertion, the study revealed that 56.5% were performed after hours (i.e. between 16h00 and 07h59) as compared with 43.5% which were performed between 08h00 and 15h59 (Table 5).

Table 5: Operative data (*N* = 115).

	Number	**Percentage (%)**
Surgeon		
Consultant	21	18.3
Registrar	73	63.4
Medical Officer	21	18.3
Anesthetic		
General*	46	40
Regional	69	60
Additional procedure		
Uterine tear repair	22	19
Balloon tamponade	16	13.9
Uterine evacuation	5	4.3
Uterine artery ligation	1	0.9
Time of operation		
16h00 to 07h59	65	56.5
08h00 to 15h59	50	43.5

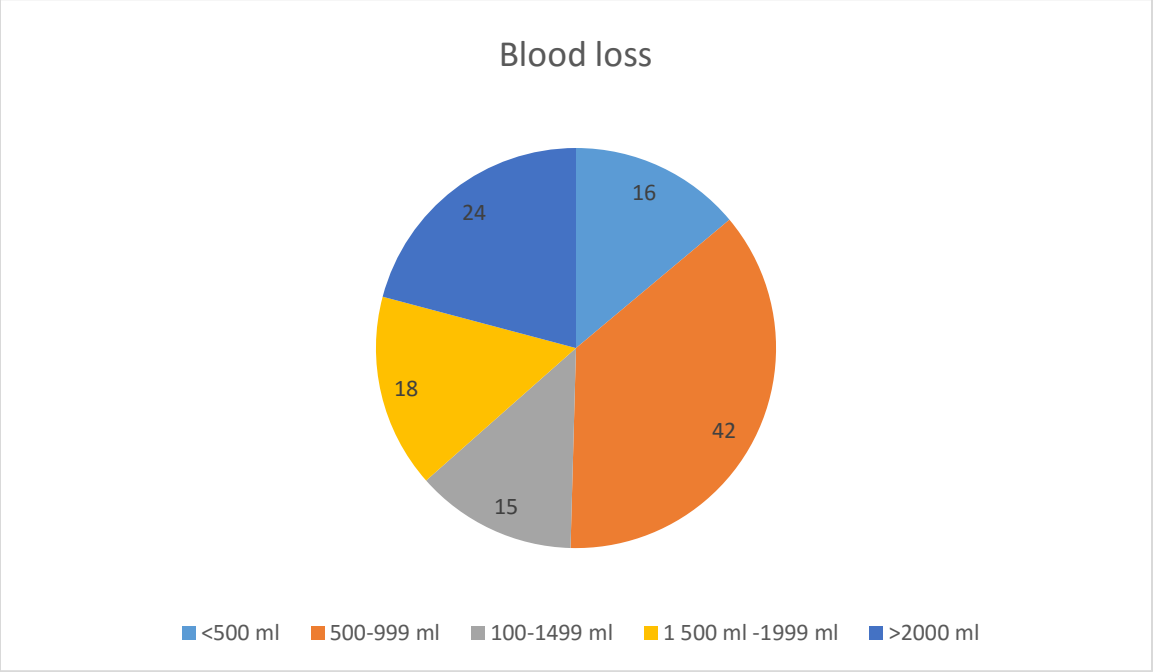
** all women who had laparotomy for UCS after NVD had GA*

Table 6: Estimated blood loss (*N* = 115).

Estimated blood loss	Number women	Percentage (%)
<500 ml	16	13.9
500–999 ml	42	36.5
1000–1499 ml	15	13.0
1500–1999 ml	18	15.7
≥2000 ml	24	20.9

**EBL values for each case were found from anaesthetic chart, theatre notes and/or theatre register.*

Figure 10: Numbers of cases with different categories of Estimated blood loss.



Information about estimated blood loss, as represented in Table 6 and Figure 3, was categorized as follows: patients who had EBL below 500 ml, between 500 ml and 999 ml, 1000 to 1499 ml, 1500 to 1999 ml, and 2000 ml or more. EBL is often a consensus of the theatre staff involved lead by the anaesthetist, subjectively looking at the all soaked swabs, linen and blood in the suction container. In our study the percentages for each category as described above were 13.9%, 36.5%, 13.0%, 15.7% and 20.9% respectively. Of note, 13.9% of UCS cases had EBL less than 500 mls and 36.6% had estimated blood loss more than 1500mls

Use of blood products

Table 7: Blood products (*N* = 115).

Blood products	**Number (*n*)**	**Percentage(%)**
Red blood cells	48	41.7
FFP/FDP	21	18.2
Platelets	4	3.5
Cryoprecipitate	3	2.6

A total number of 48 patients out of 115 who had UCS required transfusion of blood products. All 48 transfused patients received red blood cells (RBC) but, of these 48 patients, other blood products were needed which included FFP/FDP, platelets and cryoprecipitate. Patients who received all the aforementioned blood products comprised 2.6% of the 48, whereas 3.5% of the 48 patients received RBC, FFP/FDP and platelets. Those who received both RBC and FFP/FDC comprised 18.2% (Table 7).

4.5 Short-term maternal outcomes of women who had UCS for PPH

In 107 women the UCS stopped the bleeding without need for relook laparotomy, hysterectomy and the woman survived giving a 93% success rate.

Table 8 describes short-term maternal outcomes and shows that in 8 of the 115 (7%) the UCS failed with all 8 women requiring a hysterectomy; and one of the 8 died from PPH. Other complications described in Table 8 include sepsis, bladder injuries, venous thromboembolism, urinary tract infection, prolonged hospital stay and the need for blood transfusion. Twenty-one patients needed transfer to a tertiary institution for critical care, of whom 10 were admitted straight into ICU and the remaining 11 patients into the high care area.

Table 8: Short-term maternal outcomes (*N* = 115).

Complications	**Number**	**Percentage (%)**
Blood products transfusion	48	42
Transfer to GSH (high care)	11	9.6
Transfer to GSH (ICU)	10	8.7
Sepsis	11	9.6
Relook	4	3.5
Urinary tract infection	3	2.6
Venous thromboembolism	1	0.9
Bladder injury	2	1.7
Prolonged hospital stay (>3 days)	53	46.1
Failed UCS Death Hysterectomy	 1 8	 0.9 7.0

4.6 Patients who had failed UCS

The demographics of patients who had failed UCS are tabulated in Table 9. The most common associated factors among patients who had failed UCS insertion were previous CS (6 out of 8) and hypertensive disorders in pregnancy (4 out of 8). The majority of patients who had failed UCS (5 out of 8) were in labour prior to delivery, and 7 out of 8 were delivered by caesarean section (Table 10). The causes of PPH in the 8 patients who had failed UCS insertion were multifactorial: atonic uterus and uterine tear in 3 of the 8 patients, and atonic uterus and coagulopathy in 3 of the 8

patients. Only 2 out of 3 who had failed UCS insertion had only atonic uterus as a cause of PPH. One of the 8 patients who had failed UCS insertion died. The patient who died had PPH complicated by severe coagulopathy and was thought to have had amniotic fluid embolism.

Table 9: Demographics of patients with failed UCS.

No	Age	Parity	Previous C/S	GA (weeks)	Number of gestation	HIV status	Comorbidities	BMI (kg/m^2)
1	29	3	x1	29	Singleton	Negative	PET	21.3
2	42	2	x1	39	Singleton	Negative	Gest HPT	32.1
3	27	2	x1	38	Singleton	Negative	PET	30.9
4	26	2	x2	30	Singleton	Negative	nil	35.8
5	38	1	Nil	40	Singleton	Negative	nil	39.1
6	25	1	x1	40	Singleton	Negative	nil	-
7	32	3	Nil	37	Twins	Positive	PET	25.9
8	30	2	x1	38	Singleton	Negative	nil	22.6

Table 10: Operative data of patients who had failed UCS.

No	Surgeon	Cause PPH	Timing of UCS insertion	Anesthesia
1	Consultant	Atonic uterus and DIC	At CS	General
2	Registrar	Atonic uterus and DIC	At CS	General
3	Consultant	Atonic uterus and Uterine Trauma	Relook after CS	General
4	Consultant	Atonic Uterus	Post NVD	General
5	Consultant	Atonic Uterus, Uterine Trauma and RPOC	At CS	General
6	Registrar	Atonic Uterus	At CS	General
7	Registrar	Atonic Uterus	At CS	General
8	Consultant	Atonic uterus, Uterine Trauma and Coagulopathy	At CS	Regional

5. DISCUSSION

In the present study, we were able to demonstrate that UCS was safe and effective in our low-resource environment. The study has arguably one of the biggest sample sizes and is the first case series in Africa. The results show a 93% success rate, which is similar to other previously reported published studies.

5.1 Incidence

The sharp increase of UCSs performed in 2014 might have been related to the healthcare awareness created by the release in South Africa in late 2013 of the Saving Mothers Report, which indicated that obstetric haemorrhage was the leading direct cause of maternal mortality and that deaths from bleeding after Caesareans section were increasing. UCS were promoted in NCCEMD and ESMOE training materials.

5.2 Demographics

5.2.1 HIV status

Despite the high burden of HIV of 17% of the general adult population of South Africa, which is similar to that in our study population, HIV status did not seem to influence the outcomes or complications of patients who had UCS.[36] This finding might be attributed to the successful rollout of ARV treatment among HIV-positive pregnant women in South Africa.

5.2.2 Age

The mean subject age in our study was 27.54 years which was similar to that of 26.6 years found in a study performed by N Kalkal et al. in Mumbai, India,[37] which can be explained by both countries being of developing-world status with the majority of the population in the low socio-economic sector, resulting in early engagement in sexual intercourse and hence early conception ages. Poor education regarding contraception, as well as lack of access/ failure of contraceptive services in limited resourced areas may also be the contributing factors.

5.2.3 Gestational age

The mean gestational age was 38.3 months which is in keeping with other previously reported studies.

5.2.4 Pre-delivery haemoglobin

The mean pre-delivery Hb was 10.89 g/dl which is mild anaemia and may reflect the nutritional status of our population.

5.2.5 Obstetric factors

Our study showed that gestational proteinuric hypertension was the most common associated factor, occurring in 28% of women requiring UCS; and repeat caesarean section was the second most common associated factor occurring in 24%. Since this is an observational study with no control group, it is not possible to interpret this finding and may just reflect the higher rate of CS in these two groups. Much can be done to reduce the incidence of repeat caesarean section, which includes safe prevention of primary caesarean section as recommended by the American College of Obstetricians and Gynecologists (ACOG).[38]

5.3 Operative data

The present study revealed that despite the surgeons' different levels of experience, UCS was safely performed by medical officers as well as registrars and consultants. The MOs seemed to have a low threshold for performing UCS where EBL was less than 500 mls. It is possible that such UCS were performed more as prophylactic when the surgeon felt the uterus to be poorly contracted before any excessive haemorrhage was observed rather than therapeutic interventions. The study design did not explore the specific surgical reasoning for performing UCS since this is not always fully articulated in the surgeons 's notes.

The safety and efficacy of prophylactic UCS during lower caesarean section was recently investigated by Vijaysree[39] in her March 2016 study of 40 women who were high-risk for atonic uterus and who underwent emergency caesarean section. The study found that pre- and postoperative haemoglobin levels differed by 0.4–1.8 g/dl

and there were no complications during the procedure. Three months' follow-up was free of complications, and all 40 women resumed normal menstruation within 40 days after delivery. Since obstetric haemorrhage is a leading cause of direct maternal mortality in our setting and the UCS has been shown to be easy, safe and effective in treating atonic PPH, it is reasonable to recommend its prophylactic use in women at high risk for atonic PPH who require cesarean delivery.

5.3.1 Mode of delivery

Our study, as have other previously described studies, showed that a majority (92.2%) of women who required UCS delivered by caesarean section (CS). This might be explained by the increased rate of obstetric haemorrhage associated with CS compared to vaginal delivery and the underlying reason for CS such as prolonged labour being associated with PPH. Also UCS may be resorted to earlier with PPH at CS compared to after vaginal delivery because the abdomen is already open.

5.3.2 Additional procedures

Thirty-eight per cent of patients who had UCS also required other additional procedures. This raises the question of whether the indication for UCS was properly evaluated during the operation, although combination procedures such as the 'sandwich technique' described previously can play a role in patients with placenta praevia. As PPH can also be caused by numerous factors, UCS use together with another form of treatment is part of multi-modal treatment and does not necessarily indication an incorrect indication for its use.

5.4 Short-term maternal outcomes

5.4.1 Success rate

Our study shows 93% successful UCSs, similar to the figure of 93.56% in the study by Ghodake et al.[40] and many other studies preceding the current one; but the fundamental difference is our larger sample size as described in Table 11 below. While comparing different studies' outcomes, we were mindful that the threshold of performing UCS will differ, depending on different obstetric units and even from

surgeon to surgeon. Another consideration is that the definition of PPH is dynamic. The arbitrary number of more than 500 mls may not be a true reflection, not only because it is inherently inaccurate to estimate the volume of blood loss (health workers underestimate by 46% to 75%, with greater errors at high losses)[41] but also because the decision to intervene (insert UCS) might be based on how rapid the blood loss is or physiological changes such as heart rate during surgery which may be difficult to quantify for research purposes. However, the other outcomes of the study with high rated of blood transfusion and admission to high care units suggest excessive blood loss did occur for many patients. Recent Study by Senturk MB and colleagues has shown peripartum hysterectomy is associated with high evidence of postpartum depression compared to uterine sparing procedure (Hypogastric artery ligation and/or B Lynch suture) hence further suggest the benefit of UCS.[42] The overall deduction from this study favours the use of UCS as it is simple, safe, cheap and effective. There are no available randomised controlled trials (RCTs) on the use of UCS which is a short coming in the literature and the current study. However it would be difficult to perform an RCT because a bleeding, shocked patient needs some form of intervention to survive, and hence it would be unethical to compare UCS with a placebo.

Table :11 Previous studies and their different short-term outcomes.

Study	**Sample size**	**Success rate (%)**
Lynch et al. (1997)[5]	5	100
Ferguson et al. (2000)[9]	2	100
Smith et al. (2003)[12]	6	86
Koh et al. (2009)[43]	7	86
Nalini et al. (2010)[44]	72	97
Kakal et al. (2016)[36]	30	100
The present study	115	93

5.4.2 Hospital stay

The scope of our study did not allow a long-term follow-up, but the short-term outcomes were favourable and comparable with all previous studies. A significant difference is prolonged hospital admission following UCS, where 46% of the patients who had UCS stayed more that 3 days in hospital post delivery. This increase in the number of hospital in-patient days could be explained by other reasons not related to the procedure, such as the immediate morbidity associated with massive blood loss, waiting for a social worker to consult if delivery was on a weekend, or the mother lodging while the baby is in neonatal ICU. Our study did not explore all reasons for prolonged stay but post-UCS insertion complications recorded in the maternity book were very few and unlikely to be the only reasons for prolonged hospital stay.

5.5 Limitations

Thirty-five folders of the 150 folders identified could not be retrieved, and this may be a source of bias could be because the lost folders may have been those of patients who had unfavourable outcomes.

Other limitations of the study relating to problems in estimating blood loss and lack of standardisation in the threshold for performing UCS, between surgeons at MMH or between different units who have reported on UCS; were described in section 5.4.1. This was a retrospective folder review and it was hence not possible to determine whether all UCSs were appropriate or indicated. Short-term outcomes and complications were assessed, and it is not known what future fertility was in our population, although other series have indicated normal fertility.

The study also did not differentiate the different types techniques implemented hence complications associated with different technique could not be compared (opening the uterus as compared to inserting the UCS with the uterus closed). This may be a consideration for a follow up study and the surgeons would then be encouraged to document their techniques clearly in the theatre notes.

5.6 Recommendations

UCS insertion for PPH secondary to atonic uterus should be taught and used in all institutions performing caesarean section. It is a crucial skill especially for surgeons who are unable to perform hysterectomy, and has been repeatedly shown to be easy, cheap and effective. Long-term follow-up of patients who had UCS insertion is needed to assess intermediate morbidity and influence of UCS on fertility and future pregnancy outcome.

6. CONCLUSION

Since the introduction of the B-Lynch suture in 1997, the uterine compression suture has been proven to be a most valuable uterine preserving tool in the management of severe postpartum haemorrhage worldwide. Our study with a successful outcome in 93% of the 115 women requiring UCS, confirmed that the success of the UCS is achievable even in low-resource environments and that UCS can be safely performed by surgeons with different levels of surgical expertise (medical officers as well as registrars and consultants).

APPENDIX 1

UTERINE COMPRESSION SUTURE STUDY
DATA COLLECTION SHEET

Studnum	
Foldnum	
Age	
Grav	
Para	
prevcs 0=no 1=1cs etc	
prevmctop 0=no 1=yesEVAC 2=yesnoevac	
PrevSB 0=no 1=yes 2=unknown	
Gestagedel	
fetnumber 1=single 2=twins 3=triplet 4=quad or more	
HIV 0=neg 1=pos 3=unknown	
Bookinghb	
Rhesus 0=negative 1=positive 3=unknown	
RPR 0=negative 1=positive 3=unknown	
comorbid 0=none 1=hypt 2=PET 3=diabetes 4=more than one	
Delhb	
placenta 0=normal 1=praevia 2=accreta 3=other	
abruptio 0=none 1=suspected=2=confirmed	
height in metres	
weight in kilograms	
BMI	N/A
MFU 0=no 1=yes	
presentation 1=cephalic 2=breech 3=oblique 4=transverse 5=unknown	
delmode 1=NVD 2=csect 3=forceps 4=vacuum	

csect 0=no 1=emergency 2=elective	
labour 0=didn't 1=spontaneous 3=induced	
inducedmiso 1=yes 0=no	
inducedpradin 1=yes 0=no	
inducedoxyt 1=yes 0=no	
inducedarom 1=yes 0=no	
inducedicc 1=yes 0=no	
prolongl ab 0=no 1=yes 3=unknown 4=n/a	
oxytocinaol 0=no 1=yes 2=n/a	
bloodloss in ml	
unitstrfused only packed cells	
FFPFDP	
platelets	
cryoprecipitate	
medoxytocin 1=yes 0=no	
medergometrin 1=yes 0=no	
medmiso 1=yes 0=no	
medf2alpha 1=yes 0=no	
ROMdelint 1=>24hrs 2=<24hrs 3=unknown 4=n/a	
labpyrexiar 0=no 1=yes 2=n/a 3=unknown	
surgeon 1=consultant 2=registra 3=medicalofficer (this is the surgeon performing the B-Lynch)	
time start of procedure (in 24:00 format)	
suture type 1=blynch 2=hayman 3=other	
pphatony 1=yes 0=no	
pphtrauma 1=yes 0=no	
pphrpoc 1=yes 0=no	
pphretplac 1=yes 0=no	
pphpraevia 1=yes 0=no	

pphaccreta 1=yes 0=no	
pphcoagulo 1=yes 0=no	
pphabrupti 1=yes 0=no	
pphinversion 1=yes 0=no	
timepph 1=postnvd 2=duringcsec 3=postcsec	
addproctamponade 1=yes 0=no	
addproevacMRP 1=yes 0=no	
addproctearrepair 1=yes 0=no	
addprocual 1=yes 0=no	
addprocother 1=yes 0=no	
anaesthesia 1=regional 2=general (for compression suture)	
hysterectomy 0=no 1=yes	
death 0=no 1=yes	
immedcomplicbowel 0=no 1=yes	
immedcomplicbladder 0=no 1=yes	
immedcomplicureter 0=no 1=yes	
immedcomplicsepsis 0=no 1=yes	
immecomplicvte 0=no 1=yes	
immedcompliclrti 0=no 1=yes	
immedcomplicrelook 0=no 1=yes	
immedcomplicother 0=no 1=yes	
apgar1	
apgar5	
birthweight (in grams)	
postopcare 1=mmh 2=gsh 3=ICU	
postoppyrexia(=>38 degs C on 2 occasions) 0=no 1=yes	
Lengthhospstay	

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