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Surgical Management of Obstetric Complications: Postpartum Haemorrhage and Uterine Rupture

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Abstract

Background: Postpartum haemorrhage (PPH) remains the single largest direct cause of maternal death worldwide, accounting for approximately one quarter of all maternal mortality, with the greatest burden falling on low-resource settings. Uterine rupture is far less common but carries disproportionate maternal and perinatal consequences, complicating roughly 0.5 to 0.7 percent of trials of labour after one previous lower segment caesarean section and considerably more after a classical incision. Both conditions share a defining feature: outcome is determined less by the availability of any single technique than by the speed and coherence of the escalation pathway that leads to it. **Objective:** To compare the clinical, anatomical, and functional outcomes of contemporary surgical procedures for pelvic organ prolapse, assess postoperative complications and recurrence, evaluate patient satisfaction following different surgical approaches, and identify factors associated with favorable surgical outcomes. **Methods:** This prospective observational study was conducted among women undergoing surgical treatment for pelvic organ prolapse. Demographic characteristics, clinical presentation, prolapse stage, type of surgical procedure, operative findings, postoperative complications, anatomical outcomes, recurrence, and patient-reported outcomes were recorded. Patients were followed postoperatively to

assess symptom improvement, functional recovery, recurrence, and satisfaction. Surgical outcomes were compared according to the type of prolapse and operative approach. **Key Findings:** Uterine atony accounts for 70 to 80 percent of primary PPH and responds to uterotonics in the majority of cases, but delay in recognising failure of medical therapy remains the commonest contributor to preventable death. Early tranexamic acid, given within three hours of birth, reduces death due to bleeding. Uterine balloon tamponade succeeds in approximately 85 percent of atonic haemorrhage and functions as both treatment and triage test. Compression sutures, stepwise uterine devascularisation, and internal iliac artery ligation preserve the uterus when applied early by an experienced operator, whereas the same techniques attempted late in an exsanguinating and coagulopathic patient increase mortality. In uterine rupture, fetal heart rate abnormality, most often prolonged bradycardia, is the earliest and most consistent sign, and immediate laparotomy takes precedence over further diagnostic confirmation. Repair is appropriate for clean transverse lower segment defects in a stable patient desiring future fertility; hysterectomy is indicated for extensive, stellate, or laterally extending tears, broad ligament involvement, or uncontrolled haemorrhage. **Conclusion:** Surgical success in obstetric haemorrhage depends on sequence rather than technique. A rehearsed, protocol-driven escalation from uterotonics through tamponade and conservative surgery to definitive hysterectomy, supported by early haemostatic resuscitation and timely senior involvement, saves more lives than any individual operation. The decision to abandon uterine conservation, taken early and without ambivalence, is frequently the most important judgement the obstetric surgeon makes.

Keywords: Postpartum Haemorrhage, Uterine Rupture, B-Lynch Suture, Uterine Balloon Tamponade, Internal Iliac Artery Ligation, Peripartum Hysterectomy, Placenta Accreta Spectrum, Tranexamic Acid, Maternal Mortality

1. Introduction

Obstetric haemorrhage behaves unlike bleeding encountered anywhere else in surgery, and this difference is anatomical before it is clinical. At term, the uterus receives between 500 and 800 millilitres of blood every minute, roughly a fifth of the entire cardiac output, delivered through a low-resistance, high-flow circulation that has spent nine months remodelling itself for exactly that purpose. When haemostasis fails at the placental bed, a woman can lose her whole circulating volume within a handful of minutes. There is no comparable situation in general or gynaecological surgery where a healthy young patient can move from apparently normal to peri-arrest in the time it takes to send a cross-match sample to the laboratory.

She is also physiologically deceptive, and this is the trap that catches inexperienced teams most often. The plasma volume expansion of pregnancy, amounting to some 40 to 50 percent above the non-pregnant state, together with the vigorous vasoconstrictive response of a young cardiovascular system, means that blood pressure is frequently maintained until 25 to 30 percent of blood volume has already been lost. Tachycardia may be attributed to pain, anxiety, or the exertion of labour. By the time hypotension declares itself, decompensation is not approaching but already established, and the woman who looked stable ten minutes ago is now in a category from which recovery requires everything the unit has. Clinicians who have managed one such case rarely need the point restated. Those who have not tend to underestimate it.

Against that background, postpartum haemorrhage remains the leading direct cause of maternal death worldwide, responsible for approximately a quarter of all maternal mortality. The absolute burden is distributed unevenly and unjustly. Case fatality in settings with reliable blood banking, immediate theatre access, and continuously available senior obstetric and anaesthetic cover is a small fraction of that seen where any one of those elements is missing. The tragedy embedded in the global figure is that the substantial majority of these deaths are judged avoidable on structured review, and the themes identified by confidential enquiries have remained depressingly stable across decades and across continents: underestimation of blood loss, failure to recognise that a chosen treatment is not working, delay in summoning senior help, delay in mobilising blood products, and above all delay in proceeding to definitive surgery. The operations themselves are seldom the limiting factor. They are well described, largely reproducible, and available in most units that perform caesarean sections. What is scarce is the decisiveness to use them at the right moment.

Uterine rupture occupies the opposite epidemiological position but leads to the same conclusion. It is uncommon, and in a well-selected population undergoing trial of labour after caesarean it is genuinely rare. Yet when it occurs, it converts an ordinary labour into a simultaneous maternal and fetal emergency within minutes, and its management is almost entirely surgical from the moment of suspicion. The interval between recognition and delivery, measured in single-figure minutes rather than in the more forgiving timescales that govern most obstetric decisions, determines neonatal survival and neurological outcome more powerfully than any subsequent technical decision made in theatre. Both conditions therefore share a defining characteristic that shapes this entire review: outcome depends less on which operation is chosen than on how quickly the team abandoned a failing plan and moved to the next step.

1.1 Definitions, Thresholds, and Their Limitations

The traditional definitions of postpartum haemorrhage rest on estimated blood loss exceeding 500 millilitres following vaginal birth or 1000 millilitres following caesarean section. These thresholds have served for generations of teaching, but their practical value is limited by a well-documented problem. Visual estimation of obstetric blood loss is unreliable and systematically biased. Clinicians underestimate large losses, often by 30 to 50 percent, and the error widens as the volume increases, which is precisely the circumstance in which accuracy matters most. Blood is absorbed into drapes, swabs, and bedding, diluted by amniotic fluid and irrigation, and concealed within the uterine cavity, the vagina, the broad ligament, or the peritoneum.

Contemporary definitions have therefore shifted from volume alone toward physiological response. The American College of Obstetricians and Gynecologists defines postpartum haemorrhage as cumulative blood loss of 1000 millilitres or more, or blood loss accompanied by signs or symptoms of hypovolaemia, within 24 hours of birth, regardless of the mode of delivery. The inclusion of the physiological clause is the important part. A woman with a booking haemoglobin of 8 grams per decilitre and a small stature may decompensate at a volume that another woman would tolerate without a change in observations, and the definition now accommodates that reality. Quantitative measurement using calibrated under-buttock drapes and the weighing of swabs is increasingly recommended as standard practice precisely because it removes the estimation error from the decision chain.

Within primary postpartum haemorrhage, meaning bleeding within the first 24 hours of delivery, most guidelines distinguish minor haemorrhage of 500 to 1000 millilitres from major haemorrhage above 1000 millilitres, the latter often subdivided into moderate loss of 1000 to 2000 millilitres and severe loss above 2000 millilitres. Secondary postpartum haemorrhage describes bleeding occurring between 24 hours and 12 weeks after delivery, and its causes differ substantially, being dominated by retained products of conception, endometritis, and subinvolution of the placental bed rather than by acute atony. Massive obstetric haemorrhage, variously defined as loss exceeding 2500 millilitres, transfusion of four or more units of red cells, or the requirement for treatment of an established coagulopathy, is the category that correlates most closely with surgical intervention, critical care admission, and long-term morbidity, and it is the population with which this review is principally concerned.

Uterine rupture requires an equally careful definition, because the terminology is frequently used loosely in clinical handover and in the literature. True rupture is a full thickness disruption of the uterine wall including the visceral peritoneum, typically with extrusion of fetal parts, the placenta, or both into the peritoneal cavity, and it is

accompanied by haemorrhage and fetal compromise. Uterine dehiscence, sometimes described as a scar window, refers to separation of the myometrium at a previous scar with the serosa and often the fetal membranes remaining intact. Dehiscence is commonly an incidental finding at repeat elective caesarean section, is usually asymptomatic, and does not carry the catastrophic implications of true rupture. Conflating the two inflates reported incidence figures and, more importantly at the bedside, risks either unwarranted alarm or unwarranted reassurance.

1.2 Pathophysiology and the Four T Framework

Physiological haemostasis after delivery depends less on the coagulation cascade than on mechanical compression. As the myometrium contracts, the interlacing fibres surrounding the spiral arterioles, sometimes described as living ligatures, occlude the vessels of the placental bed. Clot formation follows and consolidates this mechanical seal, but it cannot substitute for it. This explains why a woman with entirely normal coagulation will bleed catastrophically from an atonic uterus, and equally why a well-contracted uterus limits blood loss even in the presence of significant coagulopathy. It also explains why the first response to postpartum haemorrhage is physical rather than pharmacological, and why bimanual compression, performed properly, remains one of the most effective interventions available in the first minutes.

The four T framework has endured because it maps causes directly onto distinct treatment pathways rather than merely arranging them into categories. Its practical utility lies in the fact that a clinician working through it is simultaneously working through a list of actions.

Table 1. Aetiology of Primary Postpartum Haemorrhage and Corresponding First-Line Response

Cause	Approximate Share	Typical Clinical Setting	First-Line Response
Tone (uterine atony)	70 to 80%	Prolonged or augmented labour, multiple pregnancy, polyhydramnios, grand multiparity, chorioamnionitis, retained clot	Uterine massage, bimanual compression, oxytocin infusion, second-line uterotonics, bladder emptying
Trauma	15 to 20%	Instrumental delivery, precipitate labour, episiotomy extension,	Systematic examination under adequate anaesthesia and lighting, surgical repair,

Cause	Approximate Share	Typical Clinical Setting	First-Line Response
		cervical or vaginal tears, uterine rupture, uterine inversion	correction of inversion
Tissue	5 to 10%	Retained placenta or placental fragments, placenta accreta spectrum, succenturiate lobe	Manual removal, ultrasound assessment, uterine evacuation under anaesthesia
Thrombin	1 to 3%	Abruption, amniotic fluid embolism, sepsis, HELLP syndrome, pre-existing or acquired coagulopathy	Haemostatic resuscitation, fibrinogen replacement, tranexamic acid, correction of underlying cause

More than one mechanism is frequently operating at once, and the proportions shift as time passes. Prolonged atonic bleeding produces dilutional and consumptive coagulopathy, converting a tone problem into a thrombin problem, which is why delay is itself an aetiological factor.

That last point deserves emphasis because it is often lost in teaching. The four T categories are not fixed compartments. A woman who begins with straightforward atony and is managed with successive uterotonics over an hour without definitive control will acquire a coagulopathy through consumption of fibrinogen and dilution by crystalloid and red cells alone. At that stage, correcting the tone no longer suffices, and the surgical problem has become considerably harder than the one that presented initially. Obstetric coagulopathy also develops earlier and faster than in comparable trauma populations, particularly in placental abruption and amniotic fluid embolism, where fibrinogen consumption is accelerated and profound. Fibrinogen falls before conventional clotting times become abnormal, and a concentration below 2 grams per litre during active bleeding is a recognised predictor of progression to severe haemorrhage.

1.3 The Evolution of Surgical Management

The surgical approach to intractable postpartum haemorrhage has changed considerably within living memory, and understanding that trajectory helps explain the current sequence of interventions. For much of the twentieth century the options available once uterotonics had failed were essentially packing and hysterectomy, with vessel ligation practised in a minority of units. Internal iliac artery ligation was described

early and remained the principal fertility-sparing manoeuvre for decades, but it demanded retroperitoneal dissection skills that were unevenly distributed and it was frequently attempted only when the patient was already unstable, which depressed its reported success.

The landscape altered in the closing years of the century. The description of the B-Lynch brace suture in 1997 offered a technically accessible, rapidly applied, uterus-preserving option that could be performed by any surgeon comfortable with caesarean section, and it was followed within a few years by the Hayman and Cho variants that widened its applicability further. The Bakri balloon, described in 2001, then provided a means of controlling atonic haemorrhage without laparotomy at all, and in doing so introduced something arguably more valuable than the device itself: a rapid diagnostic test of whether the bleeding would settle with conservative measures. More recently, intrauterine vacuum-induced haemorrhage control devices have added a further option based on the opposite mechanical principle, collapsing the cavity rather than distending it.

Pharmacological practice changed in parallel. The WOMAN trial, reporting in 2017, established that tranexamic acid given early reduces death due to bleeding in women with postpartum haemorrhage, with the benefit confined to administration within three hours of birth. Alongside these developments, interventional radiology, cell salvage, point-of-care viscoelastic testing, and protocolised massive haemorrhage pathways have all moved from specialist novelty toward expected standard in well-resourced units. The consequence is a modern escalation ladder with considerably more rungs than existed thirty years ago, which is a clear advance, but which also carries a specific hazard. More available options create more opportunities to hesitate, and each additional attempt at conservation consumes time, blood, and physiological reserve.

1.4 Uterine Rupture in Context

The epidemiology of uterine rupture is largely the epidemiology of the caesarean scar. Rupture of a previously unscarred uterus is rare in settings with accessible obstetric care, quoted in the region of 1 in 5,000 to 1 in 20,000 deliveries, and where it does occur, it is usually attributable to obstructed labour allowed to continue, injudicious use of uterotonics, high parity, or abdominal trauma. In settings where obstructed labour goes unrelieved for many hours, it remains a substantial contributor to maternal death and to obstetric fistula among survivors.

In contrast, rupture of a scarred uterus is a recognised and quantified risk of trial of labour after caesarean section, complicating approximately 0.5 to 0.7 percent of such labours following a single previous lower segment transverse incision. The figure rises

markedly with a previous classical, inverted T, or low vertical incision, where quoted rates of 4 to 9 percent make labour contraindicated. Induction and augmentation, particularly with prostaglandins, a short interdelivery interval, and single layer closure at the previous operation all shift the risk upward. Since global caesarean section rates have risen steadily over recent decades, the population at risk continues to expand, and uterine rupture is therefore a condition whose incidence is shaped by obstetric practice patterns as much as by biology.

1.5 Rationale for This Review

A considerable body of guidance exists on the prevention and medical management of postpartum haemorrhage, and the pharmacological evidence base is comparatively strong. Surgical management is less well served. Randomised comparison of operative techniques in exsanguinating haemorrhage is not feasible, since equipoise cannot be sustained at the bedside, and consequently almost all technique-specific evidence derives from observational series in which the procedure was selected by an experienced operator in a favourable case. The result is a literature that reports individual techniques in isolation while offering relatively little on the question clinicians actually face in theatre, which is not whether a given suture works but when to stop attempting it.

This review therefore approaches the subject as an escalation pathway rather than as a catalogue of procedures. It sets out the point at which medical and mechanical measures should give way to operative intervention, compares the uterus-conserving techniques against one another in terms of success, requirements, and risk, defines the indications for peripartum hysterectomy and the circumstances in which it should be undertaken without further delay, and presents an intraoperative decision framework for repair versus hysterectomy in the ruptured uterus. Throughout, the emphasis rests on sequence and timing, since these are the variables most consistently associated with survival and most amenable to improvement at unit level.

2. Resuscitation and the Threshold for Surgical Escalation

Surgery for obstetric haemorrhage is never performed in isolation. It runs in parallel with resuscitation, and the two must be managed as a single coordinated process rather than as sequential steps.

2.1 Immediate Measures and Medical Therapy

The initial response is simultaneous rather than stepwise: call for help and declare the emergency clearly, secure two large bore intravenous cannulae, take blood for cross-match, full blood count, coagulation screen, and fibrinogen, commence uterine massage

and bimanual compression, empty the bladder, and begin warmed crystalloid while blood products are mobilised.

Oxytocin remains first-line for atony. Second-line agents include ergometrine, which is contraindicated in hypertensive disease, carboprost, which is contraindicated in asthma, and misoprostol, which retains particular value where cold chain storage is unreliable. Tranexamic acid deserves specific emphasis. The WOMAN trial demonstrated that tranexamic acid reduces death due to bleeding when given to women with PPH, with the benefit concentrated in those treated within three hours of birth and no benefit demonstrable thereafter. It should be given early and should not be held back pending a decision about surgery.

2.2 Haemostatic Resuscitation and Damage Control Principles

Obstetric coagulopathy develops earlier and faster than in most trauma populations because fibrinogen consumption is accelerated, particularly in abruption and amniotic fluid embolism. Fibrinogen falls before the prothrombin time and activated partial thromboplastin time become abnormal, and a fibrinogen concentration below 2 grams per litre during active PPH predicts progression to severe haemorrhage.

- Activate the massive haemorrhage protocol early, using balanced ratios of red cells, plasma, and platelets rather than crystalloid-heavy resuscitation.
- Use point-of-care viscoelastic testing where available to guide targeted fibrinogen and factor replacement rather than empirical fixed ratios.
- Correct the lethal triad actively: prevent hypothermia with warmed fluids and forced air warming, treat acidosis by restoring perfusion, and replace ionised calcium, which falls rapidly during large volume transfusion.
- Avoid permissive hypotension strategies borrowed from trauma practice while the fetus remains undelivered, since uteroplacental perfusion is pressure dependent.

2.3 When to Stop Waiting and Start Operating

This is the judgement that determines survival, and it is consistently made too late. Practical triggers for escalation to surgical intervention include the following.

- Continued bleeding after two uterotonic agents have been given at appropriate dose and the uterus remains poorly contracted.
- Estimated or measured blood loss exceeding 1500 millilitres with ongoing loss, particularly where the rate of loss is not slowing.
- Any haemodynamic instability that recurs after an initial response to fluid and blood products.
- Bleeding of traumatic origin, including suspected uterine rupture, which is a surgical problem from the outset and will not respond to uterotonics.

• Known or suspected placenta accreta spectrum, where attempts at forcible placental separation convert a controllable situation into a catastrophic one.

A useful discipline is to set the decision point aloud and in advance. Stating that the theatre team will proceed to laparotomy if bleeding has not settled within a defined interval converts a drifting situation into a governed one, and gives the anaesthetic and blood bank teams a timeline to work to.

3. Uterus-Conserving Surgical Management of Postpartum Haemorrhage

3.1 Uterine Balloon Tamponade and Intrauterine Vacuum Devices

Uterine balloon tamponade occupies a pivotal position in the escalation pathway. A Bakri balloon, or an improvised condom catheter where dedicated devices are unavailable, is inserted into the uterine cavity and inflated with warm saline until bleeding is controlled, typically 300 to 500 millilitres. Reported success in atonic haemorrhage is approximately 85 percent across pooled series.

Its second function is diagnostic and is arguably more valuable. The tamponade test provides a rapid answer to the central question of whether the bleeding will settle with conservative measures. If bleeding stops after inflation, laparotomy can usually be avoided. If bleeding continues around or through the balloon, the patient needs an operation, and the test has bought that information in minutes rather than in units of blood. A balloon that has controlled bleeding is typically left in place for 12 to 24 hours with antibiotic cover and deflated in a controlled, staged manner with theatre availability confirmed.

Intrauterine vacuum-induced haemorrhage control devices represent a more recent addition. Rather than distending the cavity, they apply low-level negative pressure to collapse it and promote physiological myometrial contraction. Early prospective data report rapid bleeding control in the large majority of cases, with the practical advantage of a shorter treatment interval than balloon tamponade. Availability varies considerably by setting, and they should be considered an addition to the escalation ladder rather than a replacement for surgical readiness.

3.2 Uterine Compression Sutures

Compression sutures apply sustained mechanical apposition of the anterior and posterior uterine walls, mimicking the effect of manual bimanual compression in a form that can be left in situ. They are most effective when the uterus responds to compression manually on the operating table, and that simple test should be performed before choosing this route.

3.2.1 The B-Lynch Suture

The original and most widely used technique. A long absorbable suture is passed through the lower uterine segment, carried over the fundus anteriorly and posteriorly in a brace configuration, and tied while an assistant compresses the uterus bimanually. It requires an open lower segment incision, so it is most readily applied at caesarean section or following hysterotomy. Reported success in appropriately selected atonic haemorrhage exceeds 85 to 90 percent when applied early.

3.2.2 Hayman, Cho, and Modified Techniques

The Hayman suture consists of two to four vertical compression sutures passed directly from anterior to posterior uterine wall without requiring a hysterotomy, which makes it applicable after vaginal delivery. The Cho square suture apposes anterior and posterior walls in a series of squares and is particularly suited to focal bleeding from the placental bed, for example in partial accreta or after evacuation of a lower segment placental site. Pereira and other multiple transverse and longitudinal variants exist and differ mainly in configuration rather than principle.

Two cautions are worth stating explicitly. Rare but well documented complications include uterine ischaemic necrosis and pyometra, and subsequent intrauterine synechiae have been reported. Suture tension should be sufficient to compress but not to strangulate, and the uterus should be observed for adequate colour and tone before closure.

3.3 Stepwise Uterine Devascularisation

Devascularisation reduces pulse pressure to the uterus while relying on the extensive collateral supply to preserve viability and future fertility. It is performed in a defined sequence, stopping at whichever step achieves haemostasis.

- **Step 1:** Unilateral uterine artery ligation, placing a suture through the myometrium approximately 2 centimetres medial to the vessel at the level of the upper lower segment, deliberately including a portion of myometrium to avoid vessel laceration.
- **Step 2:** Bilateral uterine artery ligation, the classical O'Leary technique.
- **Step 3:** Low bilateral uterine artery ligation below the level of the bladder reflection, requiring the bladder to be reflected inferiorly first. This addresses the descending cervicovaginal branches, which are frequently the source in lower segment bleeding.
- **Steps 4 and 5:** Unilateral and then bilateral ovarian vessel ligation within the utero-ovarian ligament, medial to the ovary so that ovarian blood supply is preserved.

The technique is quick, requires no specialised instrumentation, and is well within the competence of any surgeon who performs caesarean sections. Reported fertility outcomes and subsequent pregnancy rates are reassuring.

3.4 Internal Iliac Artery Ligation

Bilateral ligation of the anterior division of the internal iliac artery reduces pulse pressure in the pelvic circulation by roughly 85 percent, converting an arterial bleeding system into something closer to a venous one that will clot. Reported success rates in experienced hands are approximately 60 to 70 percent, lower than for compression sutures largely because it is usually attempted later in the sequence and in sicker patients.

It is technically the most demanding of the conservative options. The retroperitoneum is opened over the bifurcation of the common iliac artery, the ureter is identified and reflected medially with the peritoneal leaf, and the ligature is placed around the anterior division approximately 2 to 3 centimetres distal to the bifurcation, passing the right angle clamp from lateral to medial to avoid tearing the underlying internal iliac vein. Injury to that vein is the complication that turns a difficult operation into a disastrous one. Inadvertent ligation of the posterior division or of the external iliac artery causes gluteal claudication and limb ischaemia, respectively.

The honest summary is that this procedure should be performed by a surgeon who has done it before or who is directly supervised. In a unit without that expertise, proceeding earlier to hysterectomy is the safer decision, and framing it as a failure of conservatism is a mistake.

3.5 Radiological and Adjunctive Measures

Uterine artery embolisation achieves haemostasis in approximately 85 to 95 percent of cases and preserves fertility, but it requires an interventional radiology service, a suitably equipped suite, and a patient stable enough for transfer. It is best used electively in the stable patient with ongoing moderate bleeding, or prophylactically with balloon catheters placed before caesarean in planned accreta surgery, rather than as a rescue measure in an unstable woman.

Adjuncts worth knowing include manual aortic compression, which buys several minutes while definitive measures are prepared, the non-pneumatic anti-shock garment as a stabilising and transfer measure in low-resource settings, and resuscitative endovascular balloon occlusion of the aorta in centres with the necessary expertise. Where bleeding continues after hysterectomy from a diffuse pelvic surface, abdominal and pelvic packing with a planned return to theatre in 24 to 48 hours is a legitimate damage control strategy rather than an admission of defeat.

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Table 2. Comparison of Uterus-Conserving Surgical Options in Postpartum Haemorrhage

Technique	Reported Success	Fertility Preserved	Principal Indications, Requirements, and Risks
Uterine balloon tamponade	Approximately 85%	Yes	Atonic PPH after failed uterotonics; requires no laparotomy and doubles as a triage test; risks include masking ongoing loss if bleeding continues around the balloon
Intrauterine vacuum device	80 to 95% in early series	Yes	Atony; faster treatment interval than balloon; limited availability and less long-term data
B-Lynch compression suture	85 to 90% when early	Yes	Atony responding to manual bimanual compression; needs open hysterotomy; rare ischaemic necrosis, pyometra, and synechiae
Hayman or Cho sutures	80 to 90%	Yes	Hayman applicable without hysterotomy after vaginal birth; Cho suited to focal placental bed bleeding
Stepwise uterine devascularisation	80 to 90%	Yes	Widely available and technically straightforward; requires bladder reflection for low ligation; ureteric injury if sutures placed too laterally
Internal iliac artery ligation	60 to 70%	Yes	Diffuse pelvic and lower segment bleeding; demands specific expertise; internal iliac vein injury, ureteric injury, and gluteal claudication if the posterior division is ligated
Uterine artery embolisation	85 to 95%	Yes	Stable patient with ongoing moderate bleeding; requires interventional radiology and safe transfer; risks include contrast nephropathy and rare uterine necrosis

4. Peripartum Hysterectomy

Peripartum hysterectomy is the definitive intervention when conservative measures have failed or when the clinical picture makes their failure predictable. It is performed in approximately 0.2 to 5 per 1000 deliveries depending on setting and case mix, and the indication profile has shifted markedly over the past two decades. Atony was historically the dominant reason. Placenta accreta spectrum now accounts for the majority of cases in high-income settings, a direct consequence of rising caesarean section rates.

4.1 Indications and Timing

- Failure of conservative surgical measures with continuing haemorrhage.
- Placenta accreta spectrum, particularly increta and percreta, where hysterectomy with the placenta left in situ is generally the planned procedure.
- Extensive uterine rupture not amenable to safe repair, or rupture with broad ligament extension and uncontrolled bleeding.
- Uterine inversion or infection that cannot be corrected, and rarely severe intractable uterine sepsis.

The single most consistent finding in maternal mortality reviews is that hysterectomy was performed too late rather than too readily. Where the patient is already coagulopathic, hypothermic, and acidotic, further attempts at conservation compound the problem. In a woman who is bleeding faster than she can be transfused, the operation that stops the bleeding is the fertility-sparing decision, because it is the one that leaves her alive.

4.2 Subtotal Versus Total Hysterectomy

Subtotal hysterectomy is faster, involves less dissection near the ureters and bladder, and is generally preferred in the unstable patient with atonic bleeding from the uterine body. Total hysterectomy is required when the source of bleeding is in the lower segment or cervix, which is typically the case in placenta praevia, low-lying accreta, and rupture extending into the cervix or vaginal fornices. Leaving a bleeding cervical stump in a coagulopathic patient is a recognised route to a second laparotomy.

4.3 Placenta Accreta Spectrum

The management of accreta spectrum is planned rather than reactive wherever antenatal diagnosis has been made. Delivery in a centre with the necessary blood bank, critical care, urology, and interventional radiology support, scheduled at 34 to 36 weeks in most protocols, with a fundal or classical incision that avoids the placenta, followed by caesarean hysterectomy with the placenta left undisturbed. Attempted removal of an adherent placenta is the step that converts controlled surgery into massive haemorrhage.

Conservative approaches, including leaving the placenta in situ with delayed involution or resorption, and techniques such as the Triple-P procedure involving perioperative placental localisation, pelvic devascularisation, and myometrial excision, are described and may have a place in carefully selected women with strong fertility wishes, managed in expert centres with reliable follow-up. They carry a real risk of delayed haemorrhage and sepsis and should not be improvised.

Preoperative ureteric stenting, cell salvage, and a named senior obstetrician and anaesthetist should be part of the standard package. Bladder involvement in percreta is common, and early urological involvement is preferable to urgent intraoperative consultation.

5. Uterine Rupture

5.1 Epidemiology and Risk Factors

The dominant risk factor is a previous uterine scar. Rupture complicates approximately 0.5 to 0.7 percent of trials of labour after one previous lower segment transverse caesarean section, rising substantially with a previous classical or inverted T incision, where figures of 4 to 9 percent are quoted and where labour is therefore contraindicated. Rupture of an unscarred uterus is rare in high-resource settings, with quoted incidences in the region of 1 in 5,000 to 1 in 20,000 deliveries, but remains a significant cause of maternal death where obstructed labour goes unrelieved.

- **Uterine factors:** Previous caesarean section, especially classical, inverted T, or low vertical incision; previous myomectomy entering the cavity; previous uterine perforation or rupture.
- **Labour factors:** Induction and augmentation of labour, particularly with prostaglandins, and higher oxytocin doses; short interdelivery interval under 18 months; single layer closure at previous caesarean.
- **Obstetric and fetal factors:** Obstructed labour, malpresentation, grand multiparity, macrosomia, fetal anomaly, internal podalic version, difficult instrumental delivery, and abdominal trauma.

5.2 Recognition

The classical teaching of a triad of pain, bleeding, and cessation of contractions is unreliable in practice. Epidural analgesia masks pain, and external bleeding may be minimal because much of the loss is intraperitoneal.

The most consistent and earliest sign is fetal heart rate abnormality, most often a prolonged deceleration or sustained bradycardia, present in the substantial majority of cases. Other features include scar tenderness or a change in the character of pain, loss of the presenting part on vaginal examination with a rising station, maternal tachycardia

disproportionate to blood loss, haematuria, a palpable fetal part abdominally, and sudden cessation of previously effective contractions.

The practical rule is unambiguous. In a woman labouring with a uterine scar, sudden fetal bradycardia is uterine rupture until proven otherwise, and it is proven in theatre rather than on the labour ward. Waiting for confirmatory imaging or a second opinion costs neonatal outcome. Neonatal survival and neurological outcome fall sharply when the interval from onset of bradycardia to delivery exceeds roughly 18 to 20 minutes.

5.3 Operative Management: Repair Versus Hysterectomy

The laparotomy sequence is deliver, control, assess, then decide. Deliver the fetus and placenta immediately, secure the bleeding points and the uterine angles with clamps or sutures, and only then perform a systematic assessment of the extent of the defect, the state of the bladder, the ureters, the broad ligament, and the cervix. Decisions made while blood is still pouring are usually wrong.

Table 3. Intraoperative Decision Framework in Uterine Rupture

Factor	Favours Repair	Favours Hysterectomy
Defect morphology	Clean transverse lower segment tear with identifiable, viable, approximable edges	Stellate, ragged, longitudinal, or multiple defects; devitalised or friable margins
Extension	Confined to the lower segment	Lateral extension into the broad ligament, uterine vessels, cervix, or vaginal fornix
Haemostasis	Bleeding controlled after clamping the angles	Continued bleeding despite systematic control; expanding broad ligament haematoma
Maternal condition	Haemodynamically stable, normothermic, not coagulopathic	Shock, established coagulopathy, hypothermia, acidosis, prolonged operating time
Fertility wishes	Strong desire for future pregnancy, counselled about recurrence and elective delivery	Family complete, or fertility considerations outweighed by immediate survival
Associated pathology	Healthy uterus otherwise	Coexisting accreta spectrum, infection, or extensive necrosis

These factors are weighted rather than absolute. A single strong indication, such as an expanding broad ligament haematoma in an unstable and coagulopathic woman, overrides several factors that would otherwise favour conservation.

Where repair is undertaken, devitalised edges are trimmed, the defect is closed in two layers with delayed absorbable suture, and haemostasis is confirmed after a period of observation rather than immediately after the final knot. The ureters must be traced where the tear extends laterally, and the bladder inspected in every case, since bladder injury is a common accompaniment of anterior lower segment rupture and of rupture following previous caesarean where the bladder is adherent. Retrograde bladder filling with dye or intraoperative cystoscopy is worthwhile when there is any doubt.

5.4 Subsequent Pregnancy After Repair

Counselling should be specific rather than general. Recurrence risk after repair of a lower segment rupture is quoted in the region of 5 to 15 percent, rising to as high as 32 percent where the previous rupture involved the upper segment or fundus. Standard recommendations are early booking with consultant-led care, delivery in a unit with immediate theatre and neonatal facilities, and planned caesarean section before the onset of labour, generally at 36 to 37 weeks. Labour is contraindicated. Some women will decline further pregnancy once these figures are explained clearly, and that conversation is best held at a postnatal appointment rather than in the immediate postoperative period.

6. Outcomes, Complications, and Postoperative Care

Survival after major obstetric haemorrhage is high in well-resourced settings, but morbidity is substantial and frequently underestimated in follow-up.

Table 4. Complications Following Surgical Management of Obstetric Haemorrhage

Complication	Frequency	Clinical Comment
Massive transfusion and coagulopathy	Common in severe PPH	Requires protocolised product ratios, fibrinogen replacement, and calcium monitoring
Acute kidney injury	5 to 15%	Usually pre-renal from hypoperfusion; largely reversible with prompt correction
Bladder injury	5 to 10% of peripartum hysterectomies	Higher in accreta spectrum and anterior rupture; inspect routinely and repair primarily
Ureteric injury	1 to 3%	Associated with lateral extension, low devascularisation, and internal iliac ligation

Complication	Frequency	Clinical Comment
Return to theatre	5 to 10%	Most often for continued bleeding or pelvic haematoma; plan packing removal proactively
Intensive care admission	Variable, up to 30% in severe cases	Driven by transfusion volume, respiratory support needs, and vasopressor requirement
Venous thromboembolism	1 to 3%	Risk rises after major haemorrhage and surgery; restart prophylaxis once haemostasis is secure
Sheehan syndrome	Rare	Consider in failed lactation, persistent fatigue, or amenorrhoea after severe hypotension
Asherman syndrome and secondary infertility	Rare after compression sutures	Consider in secondary amenorrhoea or recurrent pregnancy loss following uterine conservation
Psychological sequelae	Substantially under-recognised	Post-traumatic stress and grief after hysterectomy; structured debriefing and follow-up are essential

6.1 Postoperative Priorities

- High-dependency observation with hourly urine output, serial haemoglobin, coagulation screen, fibrinogen, and lactate.
- Maintain a high index of suspicion for concealed bleeding; a rising pulse with a falling urine output precedes hypotension.
- Antibiotic prophylaxis where balloons, packs, or compression sutures remain in situ, with a defined removal plan and named responsible clinician.
- Restart thromboprophylaxis once haemostasis is secure, since the postpartum period following major haemorrhage carries a high thrombotic risk.
- Arrange structured debriefing with the woman and her partner before discharge, and a consultant-led follow-up appointment to discuss what happened, what was done, and what it means for future pregnancy.

7. Prevention, Systems Factors, and Limitations of the Evidence

Active management of the third stage of labour, particularly prophylactic oxytocin, remains the single most effective preventive intervention and reduces PPH incidence by roughly 60 percent. Antenatal correction of anaemia, risk stratification at admission, quantitative rather than visual measurement of blood loss, and structured PPH bundles

with regular multidisciplinary drills have all been associated with reduced severe maternal morbidity. Careful selection for trial of labour after caesarean, with cautious use of induction agents and continuous fetal monitoring, is the corresponding preventive strategy for uterine rupture.

- **Absence of randomised surgical data:** Randomised comparison of surgical techniques for PPH is largely absent, since equipoise cannot be maintained during exsanguinating haemorrhage. Nearly all technique-specific evidence is observational.
- **Selection bias in reported series:** Reported success rates for conservative surgery are drawn from series in which the procedure was chosen by an experienced operator in a favourable case, so they are unlikely to reflect outcomes in unselected practice.
- **Rarity of uterine rupture:** Uterine rupture is too uncommon for prospective trials, and observational data are influenced heavily by unit protocols, monitoring practice, and decision-to-delivery capability.
- **Heterogeneity of outcome definitions:** Blood loss estimation remains inconsistent between studies, which limits comparability of thresholds and outcomes across the literature.
- **Limited generalisability:** Most technique-specific evidence originates from well-resourced settings, whereas the burden of mortality falls where blood products, theatre access, and skilled personnel are least available.

8. Conclusion

The surgical management of obstetric haemorrhage is less a catalogue of operations than a discipline of sequence and timing. The techniques themselves are well described, largely straightforward, and available in most units. What separates a woman who goes home with her uterus from one who does not, and occasionally from one who does not go home at all, is how quickly the team recognised that the current plan was failing and moved to the next step.

Three principles carry most of the weight. Give tranexamic acid early. Use the tamponade test to convert uncertainty into a decision. And when conservation is failing in a patient who is becoming cold, acidotic, and coagulopathic, proceed to hysterectomy without further negotiation, because at that point it is the operation that preserves life rather than the one that sacrifices fertility.

In uterine rupture, the corresponding principle is even simpler. Sudden fetal bradycardia in a scarred uterus belongs in theatre, not in a discussion. Neonatal outcome is decided in the first twenty minutes, and no subsequent technical excellence recovers time lost at the beginning.

What is likely to improve outcomes further is not a new instrument. It is better systems: quantitative blood loss measurement as standard, viscoelastic testing at the point of care, rehearsed massive haemorrhage protocols, planned regional pathways for accreta spectrum, and enough drills that the sequence runs automatically when the room is loud and the floor is wet. Those are unglamorous interventions. They are also the ones that have consistently reduced maternal death.

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