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Internal Iliac (Hypogastric) Artery Ligation

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BACKGROUND HISTORY

The historical background of ligature of the internal iliac artery for the control of hemorrhage is not clear[1]. Numerous publications have attributed the procedure to different surgeons in diverse specialties worldwide[2–4]. In the United Kingdom and the United States, the operation was reported before 1900 and, since then, many surgeons have practiced it and found it useful.

Howard Kelly first pioneered ligation of the internal iliac (hypogastric) artery in the treatment of intraoperative bleeding from cervical cancer prior to this technique being applicable to postpartum hemorrhage[5]. Studies have shown that, in postpartum hemorrhage, the reduction of pulse pressure may only be achieved in 48% of cases. It is for this reason that other workers have advocated bilateral ligation of the internal iliac arteries to significantly improve the chances of reducing pelvic pulse pressure and facilitate hemostasis[5]. Reported complications include nerve injury, inadvertent ligature of the common iliac artery, prolonged blood loss and prolonged operative time. It has also been reported that there is a high rate of complication and low rate of success for hemostasis if the procedure is not done correctly[6]. Therefore, this procedure should be reserved for hemodynamically stable patients of low parity in whom future child-bearing itself is of paramount concern.

Unilateral or bilateral hypogastric artery ligation can be life-saving in patients with massive postpartum hemorrhage[6,7]. Although surgeons may be reluctant to perform bilateral hypogastric artery ligation for fear of injury to the pelvic viscera, there is no evidence that this is the case or that there is any significant impairment of function of the pelvic viscera. If the procedure is performed correctly, there is no morbidity, either short- or long-term[7].

Historically, the practice of internal iliac ligation was within the competency of most obstetricians and gynecologists. Today, however, subspecialization means that their training and experience may be insufficient, so pelvic floor specialists or vascular surgeons are often called upon when internal iliac artery ligation is required.

INTRODUCTION

In 1963, Lane and Aldemann reported that hemorrhage was one of the major causes of maternal mortality in the United States[8]. Eastman correlated this in an extensive review of the literature[9]. Any obstetrician who attends and experiences a case of severe postpartum hemorrhage clearly understands the risk of losing a patient from hemorrhage. The memory will last for ever. Modern methods offer the likelihood of resuscitation and survival through competent management by medical means or conservative surgery before such patients reach the point of exsanguination[10]. However, when it becomes obvious that conservative methods have failed, unilateral or bilateral internal iliac artery ligation should be considered urgently[5,11,12].

ANATOMICAL CONSIDERATIONS

The pelvic vasculature is arranged in such a manner that there is ample collateral circulation[13] (Tables 1–3). The common iliac artery bifurcates into two main branches – the external iliac artery (which becomes the femoral artery at the inguinal ligament) and the internal iliac (hypogastric) artery which descends into the true pelvis. The latter divides into anterior and posterior branches. It is essential to identify this division because the uterine artery branches off from the anterior division.

Clinical anatomy

The level of bifurcation of the common iliac artery is quite constant, and there are two easily identifiable

Table 1 Branches of the internal iliac artery

Posterior division	*Anterior division*
Parietal	*Visceral*
Iliolumbar	Umbilical
Lateral sacral	Superior vesical
Superior gluteal	Middle hemorrhoidal
Obturator	Uterine
Internal pudendal	Vaginal
Inferior gluteal	

Table 2 Anastomoses of internal iliac arteries

Branch of internal iliac	*Anastomotic vessels*
1. The uterine arteries	1. Right and left ovarian arteries (direct branches of the aorta)
2. Inferior and middle hemorrhoidal	2. Superior hemorrhoidal artery (branch of inferior mesenteric)
3. Pubic branches of obturator	3. Inferior epigastrics (branch of external iliac)
4. Inferior gluteal	4. Circumflex and perforating branches of the deep femoral artery
5. Superior gluteal	5. Lateral sacral (posterior branches)
6. Iliolumbar	6. Lumbar artery (from aorta)
7. Lateral sacral	7. Middle sacral
8. Vesical arteries	8. Branches of the uterine and vaginal arteries

Table 3 Major pelvic anastomoses

Vertical
1. Ovarian artery (branch of aorta) with the uterine artery
2. Superior hemorrhoidal artery (branch of inferior mesenteric) with middle hemorrhoidal artery
3. Middle hemorrhoidal artery with inferior hemorrhoidal (branch of internal pudendal from hypogastric)
4. Obturator artery with inferior epigastric artery (branch of external iliac)
5. Inferior gluteal artery with circumflex and perforating branches of deep femoral artery
6. Superior gluteal artery with lateral sacral artery (posterior branches)
7. Lumbar arteries with iliolumbar artery

Horizontal
1. Branches of vesical arteries from each side
2. Pubic branches of obturator from each side

guides. These are the sacral promontory and a line drawn between both anterior superior iliac spines. The bifurcation of the common iliac artery is found at the level of both of these landmarks in the majority of patients. Reich and co-workers in 1964[14] used dissection of fresh cadavers to show that numerous variations occur in the anatomy of these vessels. It is not always true, for example, that one or both of the internal iliac (hypogastric) branches of the common iliac artery are of similar diameter along the entire length. Therefore, visual observation alone can be misleading. Likewise, there may be some difference in the length and diameter of the right and left internal iliac arteries. Surgeons should therefore be aware of the fact that subdivision of the main internal iliac trunk may be into branches that are not significantly narrower than the main trunk.

The important anatomical relations of the internal iliac (hypogastric) artery can be summarized as follows:

(1) Anterior medial – covered by peritoneum (the internal iliac artery is entirely retroperitoneal);

(2) Anterior – the ureter (retroperitoneal and attached to the peritoneum);

(3) Posterolateral – the external iliac vein and the obturator nerve;

(4) Posteromedial – the internal iliac vein;

(5) Lateral – the psoas major and minor muscles.

Physiology of internal iliac artery ligation

Because of the excellent collateral circulation in the pelvis, vascular compromise does not occur when one or both internal iliac arteries are ligated. At one time, ligation of the hypogastric system was regarded as equivalent to shutting off all the blood to the area. Fortunately, this is not true. If it were, it is likely that the procedure would not be harmless. In reality, the hypogastric artery distal to the point of ligation is never emptied of blood because the rich anastomotic network starts to function immediately after ligation[15]. What does occur is the virtual abolition of the arterial pulse pressure. This is associated with reduced mean blood pressure and rate of blood flow in the collateral system. As a result, the trip-hammer effect of arterial pulsations is abolished. The surgeon must be aware that bilateral ligature of the internal iliac artery is more effective than the unilateral procedure in that the patient has less chance of returning to theater for secondary surgery to control hemorrhage. The reduced pressure and lack of pulsation do, however, mean that thrombosis in the vessels may remain *in situ*.

INDICATIONS FOR LIGATION OF THE INTERNAL ILIAC ARTERY

Prophylactic

Differentiation between prophylactic and therapeutic use of internal iliac artery ligation is by no means absolute. Conditions that may indicate ligation as a prophylactic measure include post-abortion bleeding, postpartum hemorrhage, atonic uterus prior to hysterectomy, abruptio placenta with uterine atony, abdominal pregnancy with pelvic implantation of the placenta, placenta accreta with intractable bleeding, and prior to total or subtotal hysterectomy when all conservative measures have failed.

Patients also considered to be at high risk for recurrent postpartum hemorrhage, those with recurrent major placenta previa, or Jehovah's Witnesses with important risk factors may be candidates for

prophylactic internal iliac ligation. Good clinical judgement is essential and, if prophylactic ligation is thought to be the best course, then it should not be delayed.

Therapeutic

Therapeutic ligation may become necessary:

(1) Before or after hysterectomy for postpartum hemorrhage;

(2) Where bleeding continues from the base of the broad ligament;

(3) Where there is profuse bleeding from the pelvic side-wall;

(4) Where there is profuse bleeding from the angle of the vagina;

(5) Where areas of diffuse bleeding are present without a clearly identifiable vascular bed;

(6) In the case of ruptured uterus in which the uterine artery may be torn at the site of its origin from the internal iliac artery;

(7) When there are additional indications including atony of the uterus where conventional methods have failed;

(8) Where extensive lacerations of the cervix have occurred following difficult instrumental delivery;

(9) Where there is significant bleeding from the lower part of the broad ligament;

(10) When there are gunshot wounds to the lower abdomen;

(11) In the case of fracture of the pelvis and intraperitoneal hemorrhage.

In such circumstances, hysterectomy alone may not be sufficient to control hemorrhage. Internal iliac artery ligation, unilateral or bilateral, may become necessary and should not be delayed in such life-threatening situations.

SURGICAL TECHNIQUES

General considerations

All obstetric surgeons should be fully aware of the indications, timing and technical aspects of unilateral or bilateral hypogastric artery ligation.

Experimental evidence by Burchell has shown that it is the abolition of the 'trip-hammer effect' of arterial pulsations that allows effective clotting to take place, so that small vessels stop bleeding[2,3]. This may explain why bilateral ligation works better than unilateral ligation.

Either a mid-line or a transverse abdominal incision may be used. The surgeon should not use an unfamiliar incision. A transverse incision may take more time, especially in obese patients. Visualization is considerably better from the opposite side of the pelvis. To work on the contralateral side, the surgeon may elect to change sides during the operation.

In most situations, bilateral ligation is preferable to unilateral ligation. Not only is hemostasis more secure, but, in addition, it allows greater confidence in making a decision not to re-explore the patient. Although it is possible to perform the operation by the extraperitoneal approach, the intra-abdominal approach is preferable except in cases of extreme obesity.

Some surgeons advocate complete transection of the internal iliac artery between two ligatures. This has no practical or physiologic advantage. On the contrary, its practice may lead to injury of the underlying veins.

The choice of material for ligating the artery depends on the preference of the surgeon. For example, 1–0 Vicryl and umbilical artery tape have been used. Two ties should be placed firmly but gently in continuity approximately 0.5 cm apart and 0.5–1 cm below the bifurcation (Figure 1).

Transabdominal approach

The abdomen is opened and the viscera packed away in the usual manner. Identification of the bifurcation of the common iliac artery is made by the two bony landmarks: the sacral promontory and an imaginary line drawn through both anterosuperior iliac spines. A longitudinal incision is made into the posterior parietal peritoneum. If the uterus is present, this incision can be started in the peritoneum on the posterior surface of the round ligament, at the junction of the middle and medial thirds. The incision is extended proximally for about 10 cm. If the uterus is absent, the incision can be started over the external iliac artery and carried proximally to the level of the bifurcation. Another method is to incise into the peritoneum directly over the bifurcation. The incision is then extended distally a few centimeters. All these incisions have one feature in common: they result in the formation of a medial and lateral peritoneal flap. The ureter is always beneath the medial flap and may be visualized, reflected, and protected with ease. The ureter normally crosses the common iliac artery from lateral to medial at a point just proximal to the bifurcation.

Once the peritoneum is opened, loose areolar tissue is separated from it by blunt dissection in the direction of the vessels, not across them to avoid unnecessary trauma. Small pieces of dental cotton ('pledgets' on long, curved forceps) are effective. The fingers also may be used. When the areolar tissue has been separated, the bifurcation comes into view. If the arteries are difficult to find, feel for a pulse (but remember that pulses may be difficult to palpate if a patient is hypotensive). The bifurcation feels like an inverted Y. The branch coming off at right angles is the hypogastric (internal iliac) artery. It courses medially and inferiorly to the palpating finger. The continuing branch is the external iliac artery. It courses laterally and superiorly out over the psoas muscles to the leg, where it becomes the femoral artery.

The surgeon must accurately identify these two branches because inadvertent ligation of the external iliac artery will produce an acutely ischemic leg, and limb loss is then a risk. If the external iliac artery is ligated, the ligature can be cut but it must then be checked for adequate flow, because the inner layer of the wall may have been disrupted. If the artery has been transected, then it needs to be formally repaired and a graft may be required. The attendance of a vascular surgeon becomes essential.

The common and internal iliac arteries are often adherent to the underlying veins which can be difficult to see, particularly beneath the origin of the internal iliac artery. This is the most hazardous part of the operation. Good retraction of the pelvic contents and displacement of the arteries are needed to visualize the veins. Meticulous dissection with scissors is required to separate the internal iliac vein from the artery if they are adherent. Once a plane has been developed between them, a Mixter or other fine right-angled forceps, or the forceps designed by Reich and colleagues[13] are gently introduced between them. This is best done onto the tip of a finger of the opposite hand, which allows gentle manipulation of the tips of the closed forceps, while feeling if there is still tissue present which requires division by sharp dissection. Simply pushing the forceps between the artery and the vein in an uncontrolled fashion is dangerous. It is also inadvisable to try separating the artery and the vein by opening the tips of the forceps forcibly until a path has been found between them.

The peritoneum should be closed with interrupted 2–0 Vicryl because a continuous suture can kink the ureter. The procedure on the left pelvic wall may be slightly more difficult because it is frequently necessary to mobilize the sigmoid flexure at the 'white line' to obtain adequate exposure.

Extraperitoneal approach

The skin incision in the inguinal area parallels the course of the external oblique muscle. It runs 10–15 cm in length in a line 3–5 cm medial to the anterosuperior iliac spine. After the fat and subcutaneous tissues are dissected away, a muscle-splitting incision exposes the peritoneum. This is gently reflected medially, together with the ureter. Ligation is performed as previously described. Closure is the same as for a herniorrhaphy and can be time-consuming if a bilateral approach is to be carried out.

Mid-line extraperitoneal approach (uncommon)

A mid-line extraperitoneal approach to the aorta has been advocated[16]. One hospital authority extended its use to bilateral ligation of the hypogastric arteries. A mid-line abdominal incision is made. After the anterior sheath of the rectus muscle is exposed and opened below the level of the umbilicus, dissection caudal to the semilunar line of Douglas is performed, and the peritoneal and preperitoneal fat are separated. The peritoneum and its contents are reflected to the right (or left), thus exposing the retroperitoneal structures[16].

ESSENTIAL SURGICAL CONSIDERATIONS

(1) The ureter crosses the common iliac artery at the level of its bifurcation;

(2) An incision is made inferolaterally and parallel to the ureter, which can be identified visually for safe identification and dissection;

(3) Following such incision, the peritoneal flap under which the ureter runs is displaced medially and retracted away (the ureter may be controlled with a sling for safety);

(4) The internal iliac at the point of its bifurcation into the anterior and posterior divisions can be seen and palpated with its vein and the obturator nerve. It is extremely important not to damage the internal iliac vein. The main arterial branch of the internal iliac is ideal for identification and ligature by passing a right angle, blunt-ended eye needle upon which is threaded a non-absorbable suture such as silk of 0 caliber or vicryl suture of the same caliber and passed between the artery and the vein.

Postoperative care

Intensive care is necessary because these women may be moribund and have required huge blood transfusion. Large hematomas or collections of serosanguineous fluid can be drained through separate stab wounds. Usually, this is unnecessary. Antibiotics are not indicated after ligation of the arteries. Their use is dictated only by the presence of infection. Early ambulation is advisable in all cases. An indwelling catheter may be necessary to facilitate adequate assessment of urinary output in women who are at risk of serious morbidity.

Special clinical considerations

The major pitfall associated with ligation of the hypogastric artery is delay. When hemorrhagic shock is irreversible, this operation will not overcome it. Inadequate transfusion is another pitfall in the therapy of patients with severe hemorrhage. Blood loss is often seriously underestimated.

Failure to remember that the vaginal artery is a separate branch of the hypogastric artery, rather than a branch of the uterine artery, may lead the surgeon into the pitfall of an unnecessary and ineffective hysterectomy for control of bleeding. Injury to the external iliac artery from retractors or mistaken ligation of this vessel can lead to lower limb amputation. Also, accidental ligature of one or both ureters would lead to renal function impairment. Accidental incorporation of the anterior division of the sciatic nerve may lead to foot drop (Figure 1b).

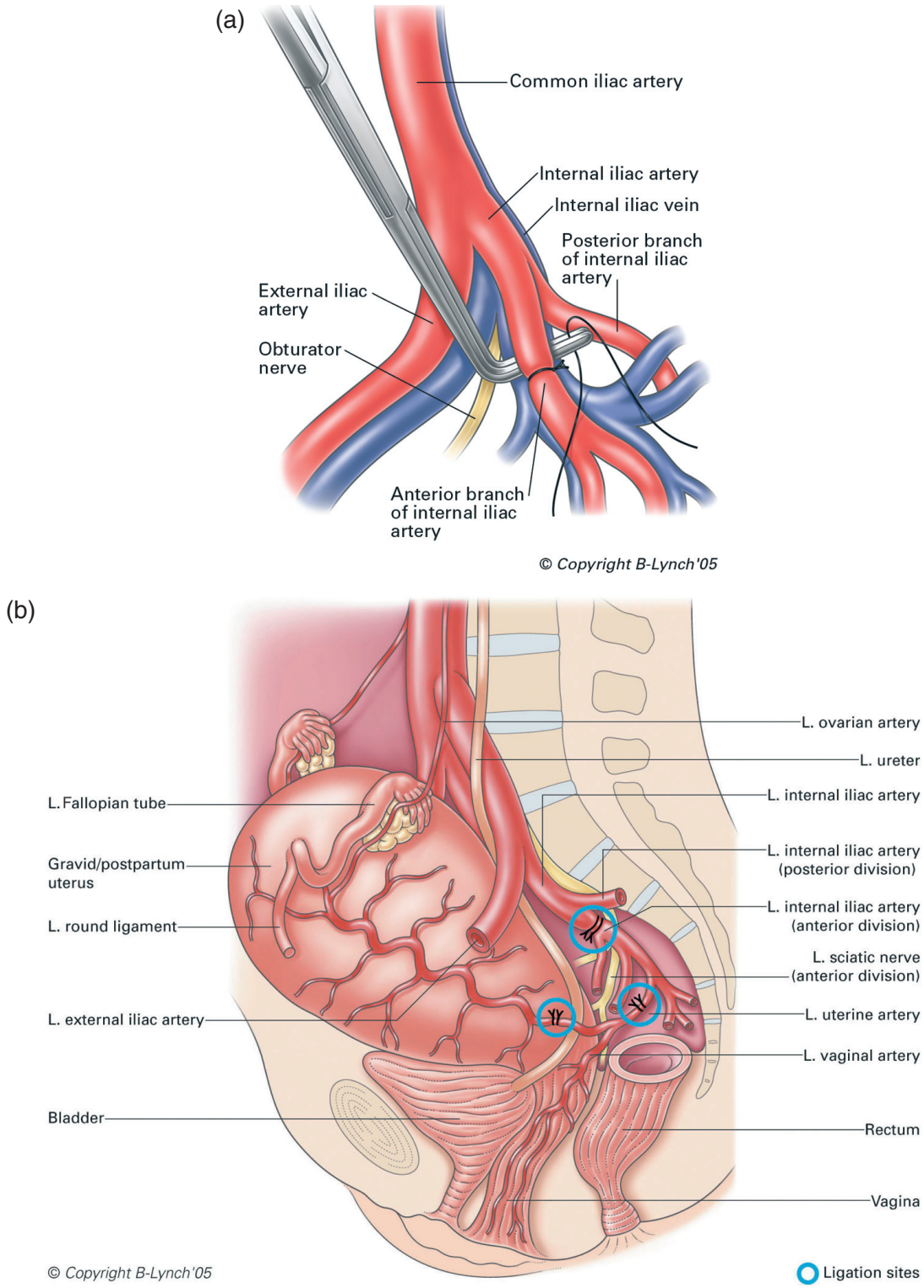

Figure 1 Ligation of the anterior branch of the internal iliac artery with its associated vein. (a) Demonstrable vulnerability of internal iliac vein and obturator nerve in close proximity; (b) A 'skeletal' anatomy, showing proximity of external iliac artery, ureter and anterior branches of sciatic nerve

Most authors consider internal iliac artery ligation to be a very safe procedure. The available data suggest that this operation does not result in necrosis of vital pelvic structures. The only report to the contrary is by Tajes[4] who cited a case of his own in which this operation resulted in necrosis of the buttocks. Tajes also reviewed two previously reported cases: in one case, the bladder mucosa sloughed, in the other, scrotal necrosis ensued. However, his report was 50 years ago.

Maintenance of reproductive function

It has not always been possible to follow young patients for whom this operation has been performed.

More important, many patients do not understand the exact nature or extent of their operation. A patient may remember only that she was sick and bleeding, that she was operated on and that she recovered.

The incidence of postoperative amenorrhea is not known. It is common for menses to resume after the operation. There have been reports of normal pregnancy and delivery occurring after bilateral hypogastric artery ligation, although it is impossible to say how frequently this occurs. It is entirely reasonable to believe that reproductive capacity is not lost after this operation, provided that the patient has a normal uterus. It is important to remember that pituitary necrosis can affect the ability to reproduce after postpartum hemorrhage, especially if blood replacement has been delayed or inadequate, hemorrhage has been severe, and shock profound. Fortunately, this is not a common occurrence in many modern and well-equipped obstetric units.

Potential failures and consequences[18]

Occasionally, ligation of the hypogastric arteries fails to stem pelvic hemorrhage. The reason for this is not clear, but some suggestions are:

(1) Massive necrosis after infection with destruction of the vessels;

(2) The presence of large, aberrant branches feeding blood to the area;

(3) Dislodgement of clots when blood pressure rises;

(4) Concomitant severe venous bleeding; however, this is rare;

(5) Coagulopathy with deranged hematological indices.

Avoiding accidental ligation of the common or external iliac artery

It is essential to identify the internal iliac artery clearly. Ligation of the common or external iliac produces an acutely ischemic leg. The classical signs are whiteness or pallor of the foot and absence of distal pulses – but these may be difficult to assess in a hypotensive, vasoconstricted patient. If there is concern that the main artery to the lower limb may have been ligated, check for a pulse in the external iliac artery above the inguinal ligament, beyond the area of ligation; the femoral pulse in the groin; or the Doppler signals at the ankle, using a hand-held Doppler. If the wrong artery has been tied, the ligature should be removed. If this fails to restore a good pulse (or if the artery has been transected), a vascular surgeon should be called to repair the vessel (either by end-to-end anastamosis or with the use of a short bypass graft of vein or synthetic material).

Damage to the ureter

Damage to either or both ureters should be avoided by careful visualization and dissection. In life-threatening surgery or delayed intervention to control massive hemorrhage, accidental damage to a ureter may occur. Ligature is more probable than transection. Prompt diagnosis and remedial surgery by a urological colleague are essential. Accidental ligature of one ureter may not lead to renal failure but increase morbidity.

Damage to other vessels

Damage to the common or iliac vein or one of its major tributaries results in brisk hemorrhage. Its source can be difficult to see and to control. It can threaten the patient's life, particularly in the context of pre-existing major blood loss from postpartum hemorrhage.

Steps to avoid damage to the iliac veins have been described in detail above: great care should be taken when dissecting in the area behind the origin of the internal iliac artery and when separating the arteries from the veins. If sudden venous bleeding does occur, the first step should be to apply firm pressure to the area. Adequate suction should be prepared – two suction tips may be helpful. Swabs mounted on sponge-holding forceps can then be applied distal and proximal to the site of damage to compress the veins and allow the defect to be visualized. If the venous defect cannot be seen, deep in the pelvis behind the iliac artery, then transaction of the iliac artery to expose the vein may solve the problem. The artery can then be re-anastamosed. When the defect in the vein has been seen, its edges can be held together using atraumatic forceps such as Stiles, before being sutured.

Repair of the vein is best performed with a non-absorbable vascular suture, such as polypropylene on a round-bodied needle. For large iliac veins, a 3/0 is a reasonable choice: needles smaller than those supplied with 4/0 sutures can be difficult to retrieve during repair of large veins and present a small danger of becoming 'lost' inside the vein. Finally, it is most important to avoid incorporating branches of the anterior division of the sciatic nerve into any ligatures[17] (Figure 1b).

USEFUL HINTS

The position of the surgeon relative to the patient

The surgeon should stand where he/she is most comfortable and this may be influenced by right- or left-handedness. The choice of the surgeon's position also depends on the ability and dexterity of the assistant. If the assistant is relatively inexperienced, then it may be particularly helpful for the surgeon to changes sides during the procedure in order to deal with each internal iliac artery from the opposite side of the operating table.

Checking for thorough control of bleeding before closure of abdomen

(1) Whilst the patient is in the frog-leg or Lloyd Davis position throughout the operation, an assistant stands between the legs and swabs the vagina to confirm bleeding has stopped.

(2) The abdomen is examined to ascertain that the ligatures have been correctly placed.

(3) The posterior abdominal wall peritoneum, which had been incised to access the posterior abdominal wall, may or may not need closure.

(4) The abdomen is checked once again thoroughly to ensure all instruments, swabs and foreign materials have been removed.

(5) The abdomen is closed according to type of the initial incision, i.e. large, pfannenstiel or mid-line. The mid-line incision is commonly closed by the mass closure technique.

(6) The sick patient should be quickly transferred directly to a high-care setting such as ITU for an appropriate length of time, to ascertain hemostasis, to ensure that pulse and blood pressure have returned to normal, and to permit surveillance of the urinary systems with a bladder catheter *in situ*.

(7) Counselling for post-traumatic stress, depression, panic attacks and flashbacks should be provided.

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