How to apply basic surgical principles to become a skilled surgeon

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Abstract

It is essential for surgical trainees to understand basic surgical principles, be able to demonstrate their competence in tissue dissection, have knowledge of surgical anatomy and to recognise variants which could make surgery more challenging. They must understand the principles of haemostasis and the safe use of energy sources. Excellent communication and team work are the cornerstones of performing safe and successful surgery. The basic principles of safe surgery and how they can be applied to minimise risk and optimise surgical outcomes will be briefly reviewed, and cases used to illustrate these points.

Keywords basic surgical principles; bladder; bowel injury; imaging; minimally invasive surgery; vascular

Introduction

It is essential for trainees in obstetrics and gynaecology to understand the basic principles of surgery, and aseptic technique. However, optimising surgical outcomes also involves careful patient counselling, selection and consenting for surgery, including alternative options, and also thorough pre-operative assessment. Surgeons should have detailed knowledge of pelvic anatomy, and the impact of gynaecological conditions such as pelvic endometriosis, chronic pelvic inflammatory disease and uterine fibroids, which can distort the normal anatomy. Such pathological anatomical changes, increase the risk of intra-operative complications causing long term impact on recovery and well being.

Pre-operative assessment

Pre-operative assessment provides an opportunity to ensure that all relevant investigations have been carried out and any important supplementary information has been obtained prior to seeing patients for consent. Alternative treatments should already have been discussed in detail, however it is good practice to ensure that these options were previously presented and that the patient still wishes to proceed with the surgical procedure which is being planned. A detailed pre-operative assessment should review the indication for the surgery, the actual type of surgery planned, and the results of any investigations which have been performed since the patient was last seen. These may be investigations requested by colleagues to assess anaesthetic risk which help to construct a plan for safe anaesthesia, or they may be tests performed to more precisely characterise the problem being treated, for example MRI or CT imaging of the renal tract in cases of severe endometriosis or extensive fibroids.

Consent

It is a general legal and ethical principle that valid consent must be obtained before starting treatment or physical examination, or providing personal care for a patient.

Consent has been described as a process whereby a competent adult makes it clear that they are able to understand what a procedure involves, has been made aware of and given the opportunity to discuss the pros and cons of this procedure and alternative management options, including dong nothing, and has received appropriate verbal and/or written information. The recent Montgomery ruling has had a significant impact on this process. No longer is it the case that a doctor taking consent must make the patient aware of complications deemed important by a reasonable body of doctors; now a doctor must inform a patient of risks and complications which they believe the patient would think were important. It is the duty of the clinician to ensure that the patient fully understands what is involved in the proposed procedure, what complications can be anticipated, and the magnitude of harm which can happen unintentionally during this approach.

The Royal College of Obstetricians has produced a number of patient consent advice documents and they are accessible at www.rcog.org. The reader is encouraged to visit the website to study the consent advice related to various surgical procedures.

Extra procedures

- Patients should be advised that extra procedures may sometimes become necessary during the procedure such as blood transfusion or repair to bladder, bowel or major blood vessels.
- Discussion should be had with women prior to gynaecological surgery as to their wishes in the event of the discovery of unexpected ovarian pathology, i.e. should ovaries be removed or left alone to be dealt with at a subsequent time.
- A record should be made of any source of information which has been provided to the patient before surgery.
- Where possible, women should be made aware of the form of anaesthesia which is being planned and should be given an opportunity to discuss this in detail with the anaesthetist before surgery.
- It should be noted that there are increased risks, both surgical and anaesthetic, associated with obesity.

Intra-operative procedures

The urinary bladder should be catheterised for major pelvic and abdominal surgery with a latex, polyurethane or silicone

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catheter. The Cochrane review concluded that routine antibiotic prophylaxis should be recommended in female surgical patients who will have a urinary catheter for more than 24 hours. Antibiotic prophylaxis should be used for major surgical procedures, and local guidance should be followed.

Surgical positioning

Good surgical positioning is vital for optimising surgical access but risk to the patient from this positioning must be minimised. The three most commonly used positions in obstetrics and gynaecology are:

1. Lithotomy position: commonly used in obstetrics, vaginal and urological surgery.
2. Trendelenburg position: commonly used in laparoscopic surgery and open abdominal surgery.
3. Lloyd-Davies position: used in pelvic and rectal surgery for optimising access to both the abdomen and the perineum.

Iatrogenic nerve injury following gynaecological surgery is a cause of postoperative neuropathy. The correct pre-operative positioning of the patient in lithotomy should involve minimal abduction and external rotation at the hip as excessive movements around the hip joint result in stretch and/or compression of the sciatic and femoral nerves. Common peroneal nerve injury is avoided by placing padding between the lateral fibular heads and the stirrups.

Tissue handling and suturing

Tissue handling should be kept to a minimum, gentle and restricted to the involved tissues, avoiding pulling or applying unnecessary force that will cause damage, increase the risk of infection, ileus and other post-operative complications. The surgeon should ensure that the retractors are positioned appropriately and that the most shallow retractor blade sufficient to provide adequate exposure should be chosen. A laparoscopic approach encourages delicate tissue handling. The primary goal for surgical suturing is to close dead space, approximate edges, minimise the risk of bleeding and infection and to support wounds until the healing process is complete. The choice of suturing technique and material depends on the type and anatomical location of the wound, thickness of the tissue and the degree of tension. As a surgical principle, non-absorbable sutures should be considered for skin, fascia and tendons (slowly healing tissues), whereas mucosal wounds (rapidly healing tissue) may be closed with absorbable sutures. (See also *Obstetrics, Gynaecology & Reproductive Medicine* 2015; **25**: 341–348 which provides a succinct account of suture materials and their use in gynaecological surgery).

Two main sources of energy can be utilised for opening tissues, and haemostasis.

An *electrical* energy source may be monopolar or bipolar. A monopolar source depends on the electrical current passing through the patient to complete the circuit, whereas with a bipolar source the current only passes through the tissue between two electrodes of the instrument. Potential complications related to the use of electro surgery include;

- Thermal damage, including burns, if there is failure of insulation secondary to damage to previously covered parts of the endoscopic equipment or if direct coupling occurs so that the active electrode touches another metal instrument. Oxygen or flammable antiseptics may ignite.
- Electric shock, particularly if a grounding pad is not used and the current is dispersed randomly throughout the body
- Transmission of bacterial or viral infection directly, or via particles in aerosol. Precautions include the use of surgical masks and eye visors, as well as the use of a smoke evacuator.

Ultrasonic energy works on the principle that ultrasound travels easily through water, which makes up roughly 80% of all soft tissue. High intensity focused ultrasound transfers a significant amount of energy to targeted tissue, causing a rise in temperature.

Surgical approach

There are two routes for accessing the abdominal cavity, open and laparoscopic.

The open approach involves making either lower transverse (Pfannenstiel/Joel-Cohen) or a midline incision.

- A low transverse incision limits access to the upper abdomen and is associated with greater blood loss, nerve entrapment and haematoma formation. The advantage of this incision is that it is easier to perform, quicker to heal and carries a lower risk of wound dehiscence and hernia. It is associated with less postoperative pain and better cosmetic outcome.
- A midline incision is most often used for gynaecological operations when dealing with large masses and cancer surgery. It usually extends from the skin fold below the umbilicus down as far as the hairline. The incision may need to be extended above the umbilicus if more extensive surgical access is required. Closure of a midline incision should be performed with delayed absorbable or non-absorbable sutures, utilising the mass closure technique which incorporates all the layers of abdominal wall except for the skin.

Minimally invasive surgery, using laparoscopic or robotic technique, is used increasingly in gynaecological pelvic surgery. Laparoscopic surgery is increasingly used for the diagnosis and treatment of both benign and malignant, acute and chronic gynaecological conditions, including management of ectopic pregnancy, benign ovarian cysts, endometriosis, infertility, endometrial cancer, incontinence and pelvic floor prolapse. The majority of laparoscopic procedures are straightforward, but serious complications occur in approximately 1:1000 cases. The laparoscopic instruments provide better illumination and magnification, thus providing a superior anatomical clarity. It has been reported that laparoscopic surgery achieves better haemostasis with less blood loss, when compared with traditional laparotomy. There remains a need however for more prospective evidence supporting the safety and detailing the complications related to various laparoscopic surgical procedures in situations of greater of complexity and co-morbidity.

There is an incremental increase in the number of women who are morbidly obese globally and this has been noted more so in the North America, and the West, as a whole. Obesity is a risk factor for gynaecological problems, such as menstrual disorder, infertility, prolapse, urinary incontinence and endometrial

cancer. Obesity adds to the challenge of managing these conditions.

Gaining access into the intra peritoneal cavity can be challenging, and obesity extends the distance between the skin and peritoneum, and the umbilicus and the bifurcation of the aorta. The Royal College of Obstetricians and Gynaecologists has published a guideline for *"Preventing entry related gynaecological laparoscopic injuries"*. This guideline recommends the use of the trans-umbilical open entry technique in morbidly obese patients when gaining access to intra-peritoneal cavity. Discussing the risk of injury to bladder, bowel or major blood vessels during insertion of the Veress needle or trocars, and their implications, is an important component of informed consent. All gynaecologists performing laparoscopic surgery should be skilled in a variety of methods of gaining access to the peritoneal cavity.

Surgical anatomy

Knowledge of normal surgical anatomy is vital for a skilled surgeon, its congenital variants and how it can be altered by acquired disease and previous surgery. This point is illustrated well for the gynaecological surgeon by the relationship of the ureter to the ovarian pedicle, and to the uterine pedicle at the level of internal os. A competent surgeon should be aware of the fact that in women with stage 3–4 endometriosis, the ureter becomes densely adherent to the posterior surface of the ovary. This is the most vulnerable site for ureteric injury when dividing the infundibulopelvic ligaments. Similar risk exists when securing the uterine vessels at the time of hysterectomy. If there is doubt regarding the integrity of the ureter/s, a second opinion should be sought intraoperatively, ideally from a urologist. In cases of complex surgery, consideration should be given for intra-operative ureteric stenting.

Case 1

A 40-year-old woman with two previous vaginal deliveries attends the gynaecology outpatient clinic with a 2-year history of increasing right sided pelvic pain. She has a lon-standing history of dysmenorrhea. An ultrasound scan performed prior to the consultation has shown a right sided ovarian cyst, consistent with an endometrioma measuring 6 cm. Pelvic examination is poorly tolerated because of pain but suggests a fixed pelvic mass. After careful discussion, she decides to proceed with laparoscopic right salpingo-oopherectomy.

The planned operation is carried out 4 weeks later. Intraoperative findings confirm moderate endometriosis with a right-sided endometrioma densely adherent to the pelvic side wall. The endometrioma is dissected using bipolar diathermy and endoscopic scissors. The right adnexa is removed endoscopically and the patient is discharged later that day.

The woman is then readmitted a week later with right flank pain. A CT-urogram shows right ureteric injury with moderate hydronephrosis. A ureteric stent is placed and subsequently removed 3 weeks later. A repeat CT-urogram confirms a functioning right ureter with resolving hydronephrosis.

Ureteric injury is an uncommon but recognised complication of gynaecological surgery. The close embryologic development and anatomic proximity of the urinary and genital organs predisposes the urinary tract to injury during surgical procedures in the female pelvis. A recent Hospital Episode Statistics (HES) database analysis reported a risk of ureteric injury of 0.5% for hysterectomies carried out between 2001 and 2010. The annual number of injuries increased from 90 in 2001 to 259 in 2010. Laparoscopic gynaecological surgery has been historically associated with a higher rate of ureteric injury. A 2015 Cochrane review of surgical approaches to hysterectomy for benign gynaecological disease gave the odds ratio of ureteric injury at laparoscopic hysterectomy as 3.46, (95% CI 0.94 to 12.71) when compared with an abdominal approach.

Morbidity arising from ureteric injury includes increased hospital stay, secondary invasive interventions, reoperation, and the potential loss of renal function. The ureter can be injured in a number of ways, including fulguration, ligation, pinching and partial or complete transection. Trauma to the sheath of the ureter and to its longitudinal blood supply can also occur (devascularisation). Risk factors for ureteric injury include an enlarged uterus, endometriosis, previous pelvic surgery, pelvic adhesions, distorted pelvic anatomy and massive intraoperative haemorrhage.

Potential consequences of lower urinary tract injury include ureteric obstruction (resulting in hydronephrosis and renal failure, if bilateral), genitourinary fistula, and urinoma.

The most common sites for ureteric injury are lateral to the cervix during division of the uterine artery, uterosacral ligament and cardinal ligament (51% of cases), the pelvic brim during division of the infundibulopelvic ligament (30%) and, as in the case above, the ovarian fossa during ovarian resection (19%). The left ureter lies closer to the midline and crosses the common iliac artery, whereas the right ureter is more lateral and crosses the external iliac artery. The left ureter is more commonly damaged.

The majority (>50%) of ureteric injuries reported occur in the absence of recognisable risk factors. Detailed knowledge of ureteric anatomy is paramount in prevention of injury. Laparoscopic surgery loses the ability to palpate the pelvic organs directly, but does provide a much-improved visibility of pelvic structures. Recognising situations of increased risk goes a long way in helping to prevent injury and critical intraoperative factors include the use of equipment with good optics and adequate illumination, having a competent assistant, and the identification and exposure, if needed, of the ureteric path in the planned course of dissection.

Caution is needed during the use of an electrical energy source along the ureteric course. Monopolar energy applied at 60 W for 2 seconds will generate sufficient heat to spread for more than 20 mm. Injury can therefore occur distant from the actual site of application of this energy. Newer, more sophisticated bipolar devices have a significantly lower thermal spread of less than 4 mm.

Prophylactic ureteric stenting or catheterisation can be performed prior to surgery in cases identified as being at higher risk of ureteric injury. The routine use of ureteric stenting is controversial however as there is risk associated with the procedure. One review of 1583 patients undergoing gynaecological surgeries, showed no difference in the risk of ureteric injury for those who were stented pre-operatively. Consideration should be given to transillumination of the ureter, using lit ureteric catheters, making the course of the ureter obvious during the surgery, although this technique has not yet been fully evaluated in gynaecological procedures. Intraoperative cystoscopy and retrograde

cannulation of the ureters may also be employed to determine the integrity of the ureters during gynaecological surgery.

Case 2

CD is a 32-year-old para 3 who is admitted electively to the day surgical unit for laparoscopic sterilisation. She has had no previous abdominal surgery her BMI is normal.

The bladder is emptied at the start of the procedure and a pneumoperitoneum is established using a subumbilical Veress needle entry. The umbilical 12-mm port is then introduced using a direct entry method and the 7-mm suprapubic port under direct vision.

The procedure is apparently straight forward without intraoperative complication.

A week later she is admitted to the gynaecology ward feeling unwell with signs and symptoms of peritonitis, and investigations show markedly deranged renal function.

A CT urogram shows free fluid within the pelvis (urine) and a bladder injury which is subsequently repaired by the urologists through a midline laparotomy.

The injury is presumed to have occurred during introduction of the suprapubic trocar.

Visceral injuries can occur during Veress needle or port insertion, or during subsequent dissection, manipulation, transection, diathermy or suturing of tissues; the injury can be direct or secondary to necrosis as a result of the use of thermal energy devices.

In cases of diagnostic laparoscopy or minor surgery without hysterectomy, bladder injuries are very unusual. However, there have been reported cases of bladder injury during a laparoscopic procedure due to the presence of an urachal anomaly, with the bladder reaching the umbilicus.

The incidence will depend on the type of procedure being performed and the level of surgical expertise. There has been a high incidence of bladder injury reported with laparoscopic assisted vaginal hysterectomy.

In contrast to ureteric injuries, more than 90% of bladder injuries at laparoscopy are diagnosed intraoperatively, which means it can be repaired at the time of primary surgery limiting morbidity. The majority of bladder injuries (90%) occur at the dome, with less than 10% being at the base. A fistula occurs in 5% of cases, usually as a result of thermal damage, and usually presenting after some delay. Separating the bladder from the uterus using thermal devices during laparoscopic hysterectomy carries this risk, particularly if there has been previous surgery (e.g. caesarean section).

However, fistulae involving the bladder may also result from inadvertent incorporation of the bladder wall during suturing of the vaginal vault. Severe endometriosis and chronic pelvic inflammatory disease increase this risk.

Prevention of bladder injury in laparoscopic gynaecological procedure

It is a good practice to ensure that the patient has voided prior to being transferred to theatre; however, catheterising the bladder just before the procedure starts ensures it is empty. Pre-operative intravenous fluids will fill the bladder very quickly.

The routine use of an indwelling urinary catheter is advised for most major laparoscopic procedures as this ensures the bladder is kept empty throughout the surgery and it can also help in recognising small bladder injuries that are not clearly visualised.

In cases of difficulty in dissecting the bladder because of adhesions due to endometriosis or previous surgery, filling the bladder with a methylene blue dye solution can help in identifying the bladder edges making any dissection easier and safer.

Avoiding the use of excessive electrosurgery near the bladder minimises the risk of thermal injury.

When suturing the vaginal vault at laparoscopic hysterectomy the bladder edge should be visualised away from the suture line in order to avoid incorporating it into the suture.

Detection

Intraoperative signs of bladder injury at laparoscopic surgery include:

- The bladder appears to be pushed by the accessory trocar as it is advanced through the abdominal wall
- The indwelling catheter bag fills with gas
- Haematuria
- Direct visualisation bladder injury
- Leakage of urine from the trocar site
- Leakage of urine or methylene blue from the bladder itself

Cases of bladder injuries that are not recognised at the time of primary surgery may present at a later date with serious complications such as urinary peritonitis or bladder fistula, both necessitating major surgery.

The diagnosis of urinary peritonitis may be delayed due to the non-specific nature of the symptoms and a low index of suspicion is these cases. Patients with urinary peritonitis usually present with abdominal pain, low back pain, leucocytosis and signs of peritoneal irritation or peritonitis 1–4 days after the bladder injury. Profound disturbances in serum electrolytes and acid-base status (elevated serum urea, creatinine, and potassium, decreased serum sodium and CO_2 content, and development of metabolic acidosis) are consistent findings among patients with intraperitoneal bladder rupture. When urine enters the peritoneal cavity, reverse auto dialysis occurs. Urea and creatinine diffuse down their concentration gradients into the blood, producing a characteristic biochemical profile of pseudo-renal failure. The diagnosis can be confirmed by performing a pelvic ultrasound detecting free fluid within the pelvis and a cystogram or CT urogram to confirm the bladder injury. Vesicovaginal fistula usually presents several weeks after the initial surgery with passage of urine through the vagina.

Management

If the bladder injury is detected at the time of laparoscopy it must be repaired at the same time. Injuries that are less than 1 cm may be managed conservatively with an indwelling Foley catheter for 7 days. A cystogram is usually performed prior to removing the catheter to ensure healing of the injury.

Larger injuries should be closed at the time they are recognized, usually with absorbable suture (PDS or Vicryl), in two layers. Methylene blue dye can be used to check that the injury has been closed completely. A Foley catheter should be left in-stu for 7 days and a cystogram performed prior to removal of the catheter.

If thermal bladder injury has occurred, tissue may need to be debrided before the repair, to prevent breakdown of the suture

line, secondary to the failure of necrosed tissues to heal normally.

A joint team approach (urologists and gynaecologists) is necessary for patients who present with bladder injury after their initial surgery. ◆

FURTHER READING

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Practice points

- Detailed knowledge of pelvic anatomy is paramount in becoming a skilled gynaecological surgeon
- Careful surgical planning and pre-operative work-up is vital in minimising surgical risk
- Good surgical technique with up-to-date equipment and surgical instruments are obvious requirements for advanced laparoscopic surgery
- Competent assistants, or joint operating with experienced colleagues will minimise the risk of harm
- Limiting the use of monopolar surgical instrument will help to prevent thermal damage