Principles of safe laparoscopic surgery

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Abstract

The well-established benefits of laparoscopic surgery over open surgery and the rapid technology developments have meant that in just over 30 years laparoscopy has become the first-line modality for performing a host of operative procedures. The objective of this paper is to give a broad overview of laparoscopic surgery, to include: 1) patient positioning and how this aids surgery, 2) methods of establishing pneumoperitoneum, including the open Hassan and closed Veress needle techniques, 3) gas insufflation, 4) maintaining good vision during surgery and how this can be achieved, 5) insertion of additional ports, 6) a description of available laparoscopic instruments and their uses, 7) limitations of laparoscopy, 8) closure of port sites. Despite its advantages, serious iatrogenic complications have been reported with laparoscopic surgery and the vast majority of these are avoidable. For this reason the paper places a particular emphasis on safety during laparoscopic surgery and steps that should be taken to ensure this.

Keywords Keyhole; laparoscopic surgery; laparoscopy; safety

Introduction

The significant benefits offered by the minimally invasive approach of laparoscopic surgery have consequently seen a rapid development in the principles, practice and technology used in this field. In just over 30 years, the laparoscopic approach has become the first-line approach to many general surgical operations. The first laparoscopic appendicectomy was performed on 30 May 1980 by a German gynaecologist called Kurt Semm. During the early 1980s, news of Semm's laparoscopic appendicectomy spread throughout the world. Erich Mühe was particularly interested in the possibility of performing additional operations using the laparoscopic technique and by 1984, Mühe had worked out the details of an operative laparoscope that he called the 'Galloscope'. On September 12, 1985, he carried out the first laparoscopic cholecystectomy and the concept of 'minimally invasive surgery' was born.[1]

Unfortunately Eric Mühe did not publish his work and consequently was not recognized for performing the first laparoscopic cholecystectomy. Phillipe Mouret who was a gynaecologist, documented the first laparoscopic cholecystectomy in 1987.[2] Finally in 1999, Eric Mühe was recognized for his pioneering work and was invited by the Society of American Gastrointestinal Surgeons (SAGES) to give the Storz Lecture which he titled 'The First Laparoscopic Cholecystectomy'.[3]

The widespread adoption of the laparoscopic cholecystectomy resulted in marked improvements in equipment. With increasingly refined technology, it became possible to perform more complex procedures that consequently led to the first report of a laparoscopic colorectal operation being performed in 1991.

The use of laparoscopic surgery with the incorporation of additional programmes such as the 'Enhanced Recovery Programme' has resulted in extremely short lengths of postoperative stay. Whereas 10 years ago, the average stay following a colorectal resection was 10–14 days, papers have been published showing that patients can be discharged safely with 23 hours of their surgery.[4]

Despite all the benefits, laparoscopy carries inherent risks. The aim of the paper is to draw attention to these with potential ways of preventing them.

Principles of safe laparoscopic colorectal surgery

Safe laparoscopic surgery invariably comprises a number of crucial stages, namely:

- positioning of the patient
- gaining access to the abdomen
- insufflation of gas
- maintaining good vision
- placement of additional ports
- use of appropriate laparoscopic instruments and ligation devices
- the limitations of laparoscopy
- closure following laparoscopy.

Positioning

Initial safe positioning of the patient is necessary. Peripheral nerve injury remains a common complication of laparoscopic surgery as many of these laparoscopic resections take several hours to complete and hence it is important to protect any areas susceptible to pressure prior to commencing surgery. Particular areas of concern are the legs in the Lloyd-Davies supports, the shoulders if shoulder supports are used and the arms if suction mattresses are used. The nature of the operation and region of the abdomen being operated on will influence the position required. Examples are given below.

- Right hemicolectomy and appendicectomy requires supine positioning. An adherent mattress such as a large gel or suction mattress is required to prevent patient slippage during head-down and right-side-up positioning, which allows a good view of the caecum, terminal ileum and the ileocolic artery.
- Left-sided colonic resections require the Lloyd-Davies position, again with some form of securing mattress, as the head-down tilt required is steep (Figure 1). Shoulder supports must be well padded to prevent nerve injury.
- Laparoscopic cholecystectomy requires the patient to be supine and in the reverse Trendelenburg (head-up)

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Please cite this article in press as: Levy B, Mobasheri M, Principles of safe laparoscopic surgery, Surgery (2017), http://dx.doi.org/10.1016/j.mpsur.2017.01.010

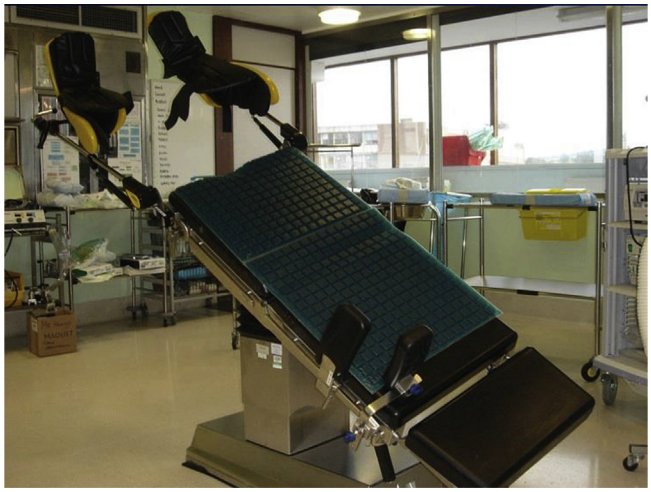

Figure 1 Table position for steep Trendelenburg.

position, with some left-sided tilt to allow good access to the gallbladder and Calot's triangle.

- Emergency diagnostic laparoscopy, commonly performed to investigate lower abdominal pain in females, requires the Lloyd-Davies position as this allows access to the female pelvic organs should the cause of pain be gynaecological.

Gaining access to the abdomen

Entry into the abdomen is performed using either an open or closed technique.

- The open 'Hassan' technique can be likened to the now infrequently used 'diagnostic peritoneal lavage' approach. Whilst there are minor surgeon-dependent variations in this approach the technique itself has become standardized. The approach commences with a small vertical skin incision (±1 cm) below or above the umbilicus depending on the position of the patient's umbilicus in relation to the territory being operated on. The cicatrix of the umbilicus is then elevated using a clip and dissection is performed to expose the abdominal fascia at the base of the cicatrix. The abdominal fascia can then be raised with sutures placed on either side of the midline or with a second clip in order to maximize the distance from the underlying intra-abdominal organs. The fascia and peritoneum is then incised in a controlled and progressive manner in order to maintain a truly open technique as opposed to bluntly pushing in instruments, which can easily cause injury. A 10-mm trochar and port is generally inserted through this opening, though with the advent of smaller scopes 5-mm ports can now be used instead.

  Inserting the trochar through the fascia has significant potential for iatrogenic injury and reports of aortic or inferior vena caval injury unfortunately occur more frequently than they should. Damage to the underlying structures can be minimized by elevating the fascia, ensuring the technique is truly open and by pointing trochars down to the pelvis away from the main vessels on insertion.

There are several variations to the described method. Some are due to surgeon choice and others are driven by specific surgical indications.

- Closed method – A Veress needle can be used to create a pneumoperitoneum prior to port insertion. The Veress needle has a spring-loaded, inner blunt stylet positioned centrally within an outer cannula that has a bevelled end. As the Veress needle is pushed through firm tissue, pressure on the tip pushes the blunt stylet into the shaft of the outer cannula, allowing the outer needle to cut through. As the needle passes through the firm layer, the blunt-tipped inner stylet springs out and serves to protect any abdominal viscera from iatrogenic injury by the sharp cannula. Once the Veress needle is in the abdominal cavity, the abdomen is filled with gas before the port is inserted.

Patients that have had previous surgery are prone to adhesion formation and carry an increased risk of visceral injury on entry into the abdomen. Special techniques may be required in such circumstances to permit safe entry. One common technique involves an open cut down at a safe site away from scars, such as Palmers point in the left upper quadrant. An alternative method of entry involves the use of a visual port. The laparoscope is mounted into this port, which is then carefully twisted through the layers of the abdominal wall and into the peritoneal cavity under direct laparoscopic vision. In this instance it is helpful to have the insufflation gas attached and flowing at the high flow rate as this aids identifying when the peritoneal cavity has been entered.

Insufflation of carbon dioxide

The abdomen is distended with carbon dioxide to create a working space and provide the necessary visualization for the surgery to be performed. Carbon dioxide is used due to its inert, non-flammable properties. In addition, its solubility allows for excretion via the respiratory route. The abdomen is insufflated with carbon dioxide up to a pressure of 12 mmHg. It is important to be aware that this pneumoperitoneum can cause cardiovascular compromise manifested as hypotension or bradycardia, through a reduction in venous return to the heart. In such a circumstance the pneumoperitoneum should immediately be released and not recommenced until the anaesthetist states that it is safe to do so.

Good vision

A clear sharp image is essential for safe surgery. The light, which originates from an external light source, is passed to the laparoscope by a fibreoptic cable. The light source can cause serious burns very quickly. It is imperative that the light source does not come in contact with the patient or the drapes when it is on. The safest way to prevent any thermal injury is to switch on the light only after it has been connected to the scope. The laparoscopes used can vary in size and can be either 5 mm or 10-mm in diameter. The 10-mm cameras in general give a better image although the new 5-mm scopes continue to improve.

Camera fog can be very disruptive to the flow of surgery. The fog forms due to condensation on the relatively cold lens. Techniques to avoid fogging include:

- placing the scope in warm water prior to insertion into the abdomen
- using a topical agent to the end of the scope to help reduce condensation.

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