Arch Gynecol Obstet (2015) 292:135–141
DOI 10.1007/s00404-014-3600-2

GENERAL GYNECOLOGY

Consideration for safe and effective gynaecological laparoscopy in the obese patient

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Received: 20 July 2014 / Accepted: 11 December 2014 / Published online: 23 December 2014

Abstract
Background The number of obese and morbidly obese patients within the developed world is dramatically increasing within the last 20 years. Apart from demographical changes, obese patients are especially prone to have oestrogen-dependent morbidities and neoplasias, of which laparoscopic treatment should be the standard of care. The increasing number of patients with BMI >40 is concerning, making it necessary to summarise considerations for safe and effective Gynaecological Laparoscopic Surgery.
Considerations The sequel to successful laparoscopic surgery in obese patients comprises an interdisciplinary appreciation of laparoscopy. Preoperatively, anaesthetics and medical review are suggested to optimise treatment of comorbidities (i.e. infections and blood sugar levels). Positioning of the patient should consider anti-slip options and pannus fixation to ease laparoscopic access and decrease pressure to the chest. There is no standard port placement in obese patients and landmarks have to be the bony structures of the pelvis and ribs. Retraction of the bowel is essential and mobilisation of the sigmoid with fan retractors or endoloops can accomplish adequate vision. 30° scopes can be considered for vision "around the obstacle". An experienced assistant with anticipation of surgical steps is favourable for successful surgery completion. Intra-operatively, good surgical techniques are essential. Vessel sealing systems reduce the need for instrument changes and may be helpful in following visualised tissue planes. A transvaginal vault closure may be advantageous compared to laparoscopic closure and Endostiches may be preferred to close the fascia of large trocar sites under vision

Keywords Gynaecology · Laparoscopy · Obesity · Safety · Feasibility

Introduction

Obesity is increasingly recognised as a major socioeconomic dilemma, which requires surgeons to re-define boundaries of diagnostic and therapeutic management options. The incidence of obesity, defined as a body mass index (BMI) of more than 30 kg/m^2, has increased exponentially within the last 50 years. In the United States of America, the adult obesity rate increased from 13.3 % in 1960 to 35.7 % in 2009–2010 [1, 2]. The WHO estimated the prevalence of obesity in 2008 for Germany, Australia and the United States of America to be 25.1, 26.8 and 33.0 %, respectively [3].

Obesity is associated with various medical conditions, including hypertension, diabetes mellitus, obstructive sleep apnoea, ischaemic heart disease, venous thromboembolic disease and endometrial cancer. Obesity has been shown to complicate surgery, with more difficult entry into the peritoneal cavity [4], increased length of surgery [5–7], blood loss and severity of complications [5]. It is well recognised at open surgery that complications such as wound infection and venous thromboembolism are more common in obese compared to non-obese patients [8].

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Within the last 20–30 years, increasing surgical and anaesthetic experience in bariatric surgery and technical advances such as improved optics and vessel sealing devices has made laparoscopic surgery on obese patients more feasible. Benefits of laparoscopic surgery include reduction in intra-operative blood loss, intraperitoneal adhesions, post-operative pain, necessity for transfusion and length of hospital stay [9, 10]. In fact, early mobilisation may provide the biggest benefit for obese patients. Additionally, in oncological laparoscopic surgery, obesity does not appear to compromise the radicality of the surgery or ability to fully stage patients [10–14].

A number of studies have demonstrated no increase in intra- or post-operative complications when laparoscopic surgery is performed on obese patients [6, 7, 15]. However, Bijen et al. [16] showed a higher conversion rate from laparoscopy to laparotomy in patients with BMI >35 kg/m^2 in a cohort of patients with early endometrial cancer. Likewise, in the GOG LAP2 study, the conversion rate increased with the patients' BMI [17]. Most authors agree that, despite the risk of conversion to laparotomy, laparoscopy is safe and cost effective and is the procedure of choice for obese patients [16].

Interestingly, even though laparoscopic gynaecological surgery in the obese patient is performed on a regular basis, the last comprehensive review on obesity and gynaecological laparoscopy was published in 2004 [18] followed by a more recent one in 2013 [19]. We searched the literature for "obesity gynaecology surgery", "obesity gynaecology laparoscopy" and "obesity laparoscopy" from January 2000 to October 2013. This review summarises the considerations for safe and effective gynaecological laparoscopy in the obese patient and draws on the experience of the gynaecological oncology surgeons from the Queensland Centre for Gynaecological Cancer (QCGC), Australia, which is a statewide oncological centre servicing a population of approximately 4 million.

Laparoscopic surgery considerations

Indications for surgery

We consider the indications for surgery and choice of modality to be identical in the obese and non-obese patient groups. Comorbidities need to be considered and less invasive treatment options exhausted. Preoperative optimisation of pre-existing conditions is paramount as discussed below. Elective surgery, especially in the obese patient, warrants sound indications and the patients should be informed of the risks and benefits of surgical and conservative options. Consenting patients and highlighting these alternative options on a consent form is recommended.

Preoperative workup

Assess the patients' adiposity tissue distribution. Compared to a huge panniculus, primary adiposity around the legs and buttocks may not hinder the abdominal surgical approach (see also patient positioning). Mobility of the panniculus can be tested during clinical examination. Appreciate that per vaginal examination results of the female pelvis may be inconclusive or flawed by thebody habitus. Palomba et al. [20] assessed intra-abdominal visceral fat distribution using ultrasound and CT and found thatthe CT results may be main predictor for early laparoscopic conversion to laparotomy.

A multidisciplinary workup with a medical and anaesthetic team is mandatory to evaluate and manage significant cardiac or pulmonary impairments. In addition, existing medical conditions (such as diabetes mellitus, hypertension and skin infections) should be optimised prior to surgery. Consideration should be given to urgent dietician review as a radical short-term weight loss program may result in a rapid loss of 10–12 kg. As much of this weight is lost from the liver, this may create more space in the peritoneal cavity for laparoscopic pelvic surgery (unpublished data, Dr. Lew Perrin).

Albeit bowel preparation is not commonly recommended for laparoscopic surgery, considerations should be given to deflate bowel loops within an obese abdomen and potentially improve laparoscopic vision. A recent experimental study on porcine models showed that mechanical bowel preparation significantly increases the intra-abdominal working space by reducing bowel content [21]. This was most prominent in low-pressure pneumoperitoneum, which is more favourable in the obese patient due to cardiopulmonary restrictions. Oral bowel preparations may be required, however, per rectal enemas are usually sufficient to empty the lower colon and improve access to the pelvis without the ramifications of dehydration or electrolyte disturbance, which is a common complication after bowel preparation.

Technically challenging surgery often requires an experienced anaesthetic and surgical team. Preoperative detailed communication with the anaesthetist to discuss patient positioning and comorbidities is essential. However, if the patient cannot be positioned sufficiently in Trendelenburg, an alternative procedure should be considered. Lamvu et al. [18] have suggested an intra-operative head-down position test to assess the patients' vital parameters before and after insufflation of the pneumoperitoneum.

Patient positioning

Patient position, especially the Trendelenburg position, is crucial for safe and successful laparoscopic pelvic surgery in the obese population. The operating table must be accredited to support the patients' weight and be wide enough to allow the arms to be tucked by the patients' 'sides'. We advocate positioning patients' arms to the side as it minimises injury to the ulnar nerve and brachial plexus and does not require an arm board that can interfere with the surgeons' operating position. Shoulder braces should be avoided as they can result in brachial plexus injuries when the patient is placed in Trendelenburg position. All patients should wear appropriately sized thromboembolic deterrent stockings and sequential calf compression devices are used intra-operatively and in the immediate post-operative period.

Lithotomy position with boot stirrups is favourable, as it allows transvaginal mobilisation of the uterus or vaginal vault and affords additional stability. Non-slip mattresses or 'bean bags' can be used to prevent downwards slippage of the patient on the operating table when placed in a head-down position; however, careful attention should be paid to protection of all pressure points, particularly at the elbow and wrist when using a bean bag, and all IV lines should be checked for patency prior to and during deflation of the bean bag. Specific attention should be paid to hips and shoulders when inflating the bean bag as these are common points where slippage can occur.

An optimal ergonomic environment is essential to minimise fatigue and injury to the surgeon. The operating table should be at its lowest position and its fulcrum should be as close to the pelvis as possible to prevent the bed from rising when it is placed in Trendelenburg position. Surgical ergonomics can also be improved using appropriately sized standing platforms. Once the patient is positioned in the final safe surgical position, palpation of the boney landmarks, such as the costal margin, pubic symphysis and anterior superior iliac spines, allows for the abdomen and pelvis to be identified and possible port placement assessed. The umbilicus is not a reliable landmark in obese patients. Additionally, the panniculus must be appreciated for appropriate port placement. In some patients with huge mobile panniculi, considerations should be given to tape the panniculus laterally so as not to interfere with port placement or add additional weight to the thorax when the patient is placed in Trendelenburg position. This may allow for a lateral abdominal approach with insertion of trocars beyond the panniculus (Fig. 1).

Fig. 1 Picture from laparoscopic lateral approach on an obese woman with BMI 57

Abdominal entry

No entry technique to establish a pneumoperitoneum is superior to another. Therefore, it is suggested to use the entry technique that the individual surgeon feels most comfortable with. Trying an unfamiliar technique is ill advised in a technically difficult case. Generally, a Hasson requires excessive dissection in obese patients; therefore, a Veres needle or direct entry technique may be preferred. Palmer's point entry within the left upper quadrant below the ribs follows a bony landmark and is safe in obese patients. Pasic et al. [22] retrospectively compared insufflation in 138 morbidly obese patients and found significantly less insufflation failure using the Palmer's point or a transuterine access, compared to a transumbilical insufflation or through open laparoscopy.

If a Veres needle is used, the surgeon should ensure that it is inserted at 90° to the perceived peritoneal cavity. In addition, obese patients are often difficult to ventilate and stomach distension is common. It is reasonable to place a nasogastric or orogastric tube to decompress the stomach prior to insertion of the Veres needle. The vertical depth from the anterior abdominal wall to intra-abdominal viscera is proportional to intra-abdominal pressure. Phillips et al. [23] found an intra-abdominal pressure of 10 mmHg to result in 0.6 cm between abdominal wall and intra-abdominal viscera, while a intra-abdominal pressure of 25 mmHg increased this distance to 5.6 cm. Reassuringly, Tsaltas et al. [24] found in 1,150 patients no untoward physiological changes at an intra-abdominal pressure of 25 mmHg when the patient is in a flat position. Therefore, an intra-abdominal pressure of 20–25 mmHg before inserting the first trocar should be considered for safety. Once safe entry into the peritoneal cavity is obtained, the pressure can be reduced to the working pressure. There is a

theoretical risk of bowel distension with the use of nitrous oxide, and as it is not a vital component of the anaesthetic, its use is not recommended [25, 26].

Port placement

The port placements for laparoscopy in obese patients require flexibility. By varying traditional port placements or the use of additional ports, access and vision may be improved. Although, the umbilicus is generally the preferred port site for its absence of fatty tissue, it has to be remembered, that the umbilicus in the obese patient is often located 3–6 cm below the aortic bifurcation [27] and this port position may not provide an ideal overview of the pelvic organs.

An initial 5-mm scope inserted at Palmer's point can assess the abdominal cavity for ideal port placements. Generally, ports need to be more superior than in non-obese patients. Depending on surgical indications, organ pathology, adhesions and adipose tissue distribution, a 10-mm optical trocar can be inserted in between the umbilicus and xiphisternum. Further 5-mm working ports are inserted under direct vision. It is suggested to have a low threshold to insert additional ports that may aid in retraction and visualisation or improve surgical ergonomics. The epigastric vessels can be difficult to be visualised in the obese patient—sudden intra-abdominal bleeding from trocar insertion wounds may suggest an injury.

It is difficult to replace ports after dislodgement in the obese patient. Considerations should be given to use ports with intra-abdominal inflatable balloons and an extra-abdominal stabiliser that helps to prevent slippage of the port (Fig. 2).

Contrary to non-obese laparoscopy, working ports should be placed in the final working-angle position once the patient is in Trendelenburg position and the panniculus has moved cephalic. This defines the trocars' working angle and reduces the impact of the abdominal wall on the manoeuvrability of the laparoscopic instruments.

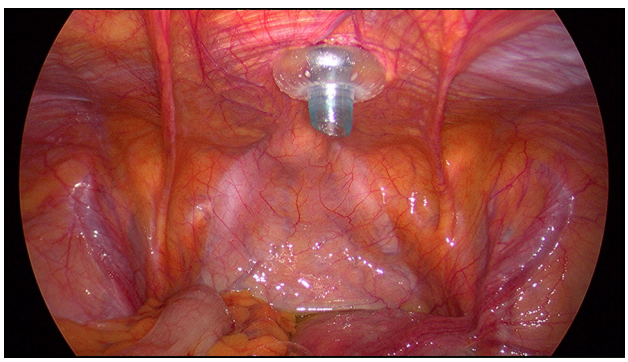

Fig. 2 5-mm Port with intra-abdominal balloon and external antagonist (not shown) to prevent port slippage (Applied Medical Australia Pty.)

Insufflation

CO_2 insufflation and keeping an adequate pneumoperitoneum remain crucial in laparoscopy on obese patients. Operating pneumoperitoneum of 15 mmHg is generally tolerated by most obese patients. However, if cardiopulmonary conditions dictate, a reduction to 10–12 mmHg can still offer adequate visualisation. Stany et al. [28] described a technique of using a mechanical retractor and a Foley catheter, inserted midline between umbilicus and pubic symphyses to elevate the abdominal wall. With this Foley Lap-Lift technique, the average pneumoperitoneum pressure could be reduced to values of 8–12 mmHg. Additionally, the peak airway pressure dropped to 20–29 cmH_2O [28].

Scope

In obese patients, there are potential benefits of using angled laparoscopes, as they enable vision of areas that may be difficult to access. However, they do have the draw back of requiring an assistant familiar with its use. Recently, a rigid scope with variable viewing angles from 0° to 120° was evaluated in advanced gynaecological laparoscopy [29]. The key benefit of this endoscope is the flexible visualisation of the surgical site without the need to move the endoscope shaft.

Access to the pelvis

Above-mentioned measures, such as bowel preparation, port placement and use of an angled laparoscope, can significantly improve access to the pelvis. Mobilising the sigmoid reflection and caecum enables the large bowel to be better reflected out of the pelvis. The sequence in which the bowel is reflected can also be important. Initially concentrating on small bowel, then the large bowel means the large bowel supports holding the small bowel out of the pelvis. Mobilisation of the caecum can also help keep small bowel out of the pelvis. Additionally, bowel can be retracted with the help of a fan retractor, such as the Endo Paddle Retract (Covidien) which is often used in para-aortic lymphadenectomy and liver surgery. Endoloops can be applied around appendices epiploicae and drawn out through the upper abdomen via a port or by means of an endoclose to help reflect the bowel into the upper abdomen. Similarly, endoloops can be used to retract ovaries toward the pelvic side wall, thereby improving vision and freeing up an instrument, that otherwise would hold the ovary. Using a straight needle to achieve this is often not possible due to the thickness of the anterior wall. A loop applied to a divided round ligament and drawn out suprapubically can help antevert the uterus and allow access to the pouch of Douglas, posterior cervix and vagina. Perivesicular fat may

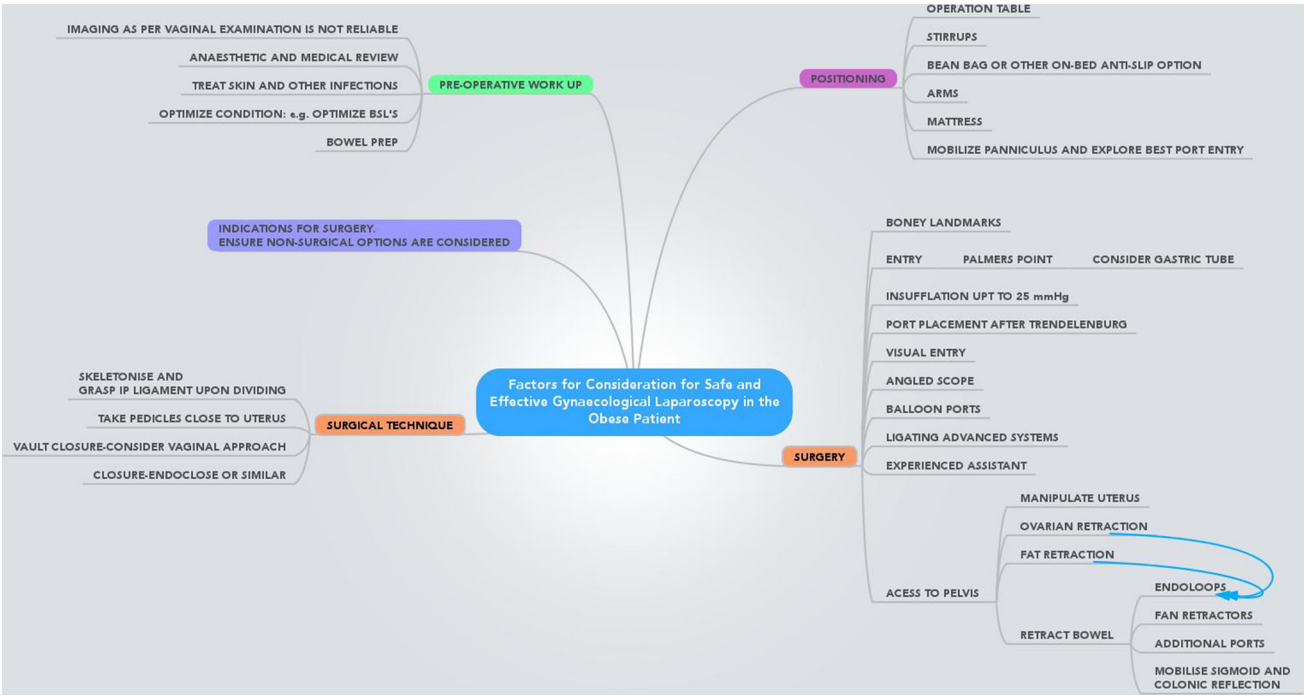

Fig. 3 Summary of considerations for safe and effective laparoscopy in the obese patient

hinder reflection of the bladder at hysterectomy. Running a prolene suture along the peritoneal edge and drawing it out suprapubically can also aid with additional traction to the bladder.

A uterine manipulator is an essential and easily applied retractor in optimising vision within the pelvis. Its use is valuable in most gynaecological laparoscopy. Former concerns of uterine manipulation being associated with a significantly higher incidence of positive cytology in oncology cases have been recanted by recent studies that did not find higher rates of either positive peritoneal cytology or micrometastasis and isolated tumour cells within sentinel lymph nodes after uterine surgery or manipulation [30–32]. In cervical cancer cases or where there is a major concern for uterus perforation, a colpotomy tube, such as the McCartney tube [33], can be used to push the uterus cranially without interfering with uterine tissue.

Specific surgical technique

All of the measures mentioned above result in enhanced vision and ease of surgical flow. One of the keys to successful laparoscopic gynaecological surgery in obese patients is the minimisation of instrument changes. Therefore, a standard approach to a surgical procedure is essential. In addition, advanced ligating systems that seal and divide are favourable. Advanced ligating systems can be used to grasp, coagulate and transect tissue. Therefore, these instruments can serve multiple functions. Again it is advisable to be comfortable with these instruments before undertaking a challenging case.

The ligation of arterial vessels at the beginning of surgery is beneficial to minimise blood loss and associated vision impairment. The uterine arteries can be easily identified by opening of the retroperitoneum proximal to the round ligament and transperitoneal traction on the obliterated umbilical artery. This will mobilise the retroperitoneal portion with the branching uterine artery.

Being able to explore the retroperitoneal space is vital for safe surgery in obese patients as structures, such as the ureter, are often not seen transperitoneally. Bleeding from divided pedicles can be difficult to salvage when access and vision is poor. Therefore, it is recommended to confirm adequate sealing prior to division. Aim to divide pedicles as distal as possible to ensure there is an adequate tissue pedicle to grasp in case of ableeding. Consider skeletalising vessels to minimise adipose tissue around vessels and further optimise ligation or coagulation.

Sealing devices do fail and having an assistant holding a structure such as the infundibulo-pelvic ligament to prevent it retracting out of view after dissection is prudent.

The approach for closing the vaginal vault after hysterectomy is subject to individual preference. The risk of vaginal vault dehiscence seems to be lowest after vaginal closure [34]. Therefore, a vaginal closure can be considered. However, body habitus may hinder vaginal surgery and laparoscopic vision may provide better access to close the vagina.

Obese patients are at risk for infections, so minimising a pelvic collection with haemostatic agents or a drain should be considered. Closing the fascia of 10 mm or bigger abdominal incisions can be aided by devices, such as the Endoclose or Berci needle, which allow closure of the fascia under direct vision. These devices can also be used to ligate a bleeding superficial epigastric vessel within the abdominal wall.

Post-operative care

Physician management of medical comorbidities is important, especially optimising blood sugar levels to enhance healing.

Thromboprophylaxis is administered 4–6 h after surgery and often continued in an extended fashion, while mechanical anti-thrombotic devices are continued until the patient is ambulatory.

Conclusion

Performing gynaecological laparoscopy on obese patients can be challenging. For the obese and morbidly obese patient, the benefits of laparoscopy may outweigh these challenges. This article summarises elements to consider performing safe and effective gynaecological laparoscopy and raises awareness of the physiological and anatomical differences in these patients (Fig. 3). Given the increasing rate of obesity amongst the population, developing laparoscopic surgical skills and sharing experience and techniques for this group is the key to enable patients to benefit from this favourable surgical approach and minimising complications.

Conflict of interest The authors have no conflict of interest concerning this paper.

References

1. Flegal KM, Carrol MD, Ogden CL, Johnson CL (2002) Prevalence and trends in obesity among US adults, 1999–2000. JAMA 288:1723–1727
2. Ogden CL, Carroll MD, Kit BK, Flegal KM (2012) Prevalence of obesity in the United States, 2009–2010. NCHS data brief, no 82. National Center for Health Statistics, Hyattsville
3. WHO Library Cataloguing-in-Publication Data Noncommunicable diseases country profiles 2011. (http://whqlibdoc.who.int/publications/2011/9789241502283_eng.pdf). Accessed 4 Apr 2013
4. Eltabbakh GH, Shamonki MI, Moody JM, Garafano LL (2000) Hysterectomy for obese women with endometrial cancer: laparoscopy or laparotomy? Gynecol Oncol 78:329–335
5. Siedhoff MT, Carey ET, Findley AD et al (2012) Effect of extreme obesity on outcomes in laparoscopic hysterectomy. J Minim Invasive Gynecol 19:701–707
6. Holub Z, Jabor A, Kliment L et al (2001) Laparoscopic hysterectomy in obese women: a clinical prospective study. Eur J Obstet Gynecol Reprod Biol 98:77–82
7. Chopin N, Malaret JM, Lafay-Pillet M-C et al (2009) Total laparoscopic hysterectomy for benign uterine pathologies: obesity does not increase the risk of complications. Hum Reprod 24:3057–3062
8. Shabanzadeh DM, Sørensen LT (2012) Laparoscopic surgery compared with open surgery decreases surgical site infection in obese patients: a systematic review and meta-analysis. Ann Surg 256:934–945
9. Janda M, Gebski V, Brand A et al (2010) Quality of life after total laparoscopic hysterectomy versus total abdominal hysterectomy for stage I endometrial cancer (LACE): a randomised trial. Lancet Oncol 11:772–780
10. Pellegrino A, Signorelli M, Fruscio R et al (2009) Feasibility and morbidity of total laparoscopic radical hysterectomy with or without pelvic lymphadenectomy in obese women with stage I endometrial cancer. Arch Gynecol Obstet 279:655–660
11. Scribner DR, Walker JL, Johnson GA et al (2002) Laparoscopic pelvic and paraaortic lymph node dissection in the obese. Gynecol Oncol 84:426–430
12. Park J-Y, Kim D-Y, Kim J-H et al (2012) Laparoscopic compared with open radical hysterectomy in obese women with early-stage cervical cancer. Obstet Gynecol 119:1201–1209
13. Moss EL, Balega J, Chan KK, Singh K (2012) Surgical and oncological outcome of total laparoscopic radical hysterectomy in obese women with early-stage cervical cancer. Int J Gynecol Cancer Off J Int Gynecol Cancer Soc 22:101–106
14. Eisenkop SM (2010) Total laparoscopic hysterectomy with pelvic/aortic lymph node dissection for endometrial cancer–a consecutive series without case selection and comparison to laparotomy. Gynecol Oncol 117:216–223
15. Heinberg EM, Crawford B III, Weitzen SH, Bonilla DJ (2004) Total laparoscopic hysterectomy in obese versus nonobese patients. Obstet Gynecol 103:674–680
16. Bijen CBM, de Bock GH, Vermeulen KM et al (2011) Laparoscopic hysterectomy is preferred over laparotomy in early endometrial cancer patients, however not cost effective in the very obese. Eur J Cancer 47:2158–2165
17. Walker JL, Piedmonte MR, Spirtos NM et al (2009) Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: gynecologic Oncology Group Study LAP2. J Clin Oncol 27:5331–5336
18. Lamvu G, Zolnoun D, Boggess J, Steege JF (2004) Obesity: physiologic changes and challenges during laparoscopy. Am J Obstet Gynecol 191:669–674
19. Scheib SA, Tanner E, Green IC, Fader AN (2013) Laparoscopy in the morbidly obese: physiologic considerations and surgical techniques to optimize success. J Minim Invasive Gynecol. doi:10.1016/j.jmig.2013.09.009
20. Palomba S, Zupi E, Russo T et al (2007) Presurgical assessment of intraabdominal visceral fat in obese patients with early-stage endometrial cancer treated with laparoscopic approach: relationships with early laparotomic conversions. J Minim Invasive Gynecol 14:195–201
21. Vlot J, Slieker JC, Wijnen R et al (2013) Optimizing workingspace in laparoscopy: measuring the effect of mechanical bowel preparation in a porcine model. Surg Endosc 27:1980–1985
22. Pasic R, Levine RL, Wolf WM Jr (1999) Laparoscopy in morbidly obese patients. J Am Assoc Gynecol Laparosc 6:307–312

23. Phillips G, Garry R, Kumar C, Reich H (1999) How much gas is required for initial insufflation at laparoscopy? Gynaecol Endosc 8:369–374
24. Tsaltas J, Pearce S, Lawrence A et al (2004) Safer laparoscopic trocar entry: it's all about pressure. Aust N Z J Obstet Gynaecol 44:349–350
25. Lewis GB (1975) Intestinal distension during nitrous oxide anaesthesia. Can Anaesth Soc J 22:200–201
26. Scheinin B, Lindgren L, Scheinin TM (1990) Peroperative nitrous oxide delays bowel function after colonic surgery. Br J Anaesth 64:154–158
27. Vaughan RW, Bauer S, Wise L (1976) Effect of position (semirecumbent versus supine) on postoperative oxygenation in markedly obese patients. Anesth Analg 55:37–41
28. Stany MP, Winter WE 3rd, Dainty L et al (2004) Laparoscopic exposure in obese high-risk patients with mechanical displacement of the abdominal wall. Obstet Gynecol 103:383–386
29. Eskef K, Oehmke F, Tchartchian G et al (2011) A new variable-view rigid endoscope evaluated in advanced gynecologic laparoscopy: a pilot study. Surg Endosc 25:3260–3265
30. Lee M, Kim YT, Kim SW et al (2013) Effects of uterine manipulation on surgical outcomes in laparoscopic management of endometrial cancer: a prospective randomized clinical trial. Int J Gynecol Cancer 23:372–379
31. Frimer M, Khoury-Collado F, Murray MP et al (2010) Micrometastasis of endometrial cancer to sentinel lymph nodes: is it an artifact of uterine manipulation? Gynecol Oncol 119:496–499
32. Sonoda Y, Zerbe M, Smith A et al (2001) High incidence of positive peritoneal cytology in low-risk endometrial cancer treated by laparoscopically assisted vaginal hysterectomy. Gynecol Oncol 80:378–382
33. McCartney AJ, Obermair A (2004) Total laparoscopic hysterectomy with a transvaginal tube. J Am Assoc Gynecol Laparosc 11:79–82
34. Blikkendaal MD, Twijnstra AR, Pacquee SC et al (2012) Vaginal cuff dehiscence in laparoscopic hysterectomy: influence of various suturing methods of the vaginal vault. Gynecol Surg 9:393–400