Followup study comparing open hysterectomy of expert surgeon and laparoscopic approach (learning curve) of the same surgeon

Thesis submitted by:

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Roll No.: ....

To the Singhania University

Department of Minimal Access Surgery

World Laparoscopy Hospital Center

Singhania University

For the Award of Masters Degree in Minimal Access Surgery

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Followup study comparing open hysterectomy of expert surgeon and laparoscopic approch (learning curve) of the same surgeon

Thesis submitted to the Singhania University in partial fulfillment of the rules and regulations for the Masters in Minimal Access Surgery Degree Examination

By:

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CERTIFICATE

This is to certify that the research name ((Followup study comparing open hysterectomy of expert surgeon and laparoscopic approch (learning curve) of the same surgeon)) done by Professor Maliheh Arab in Imam Hossein Medical center,is presented as dissertation for Masters Degree in Minimal Access Surgery Examination. the study is original embodying bonafied cases.

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Place: Imam Hossein Medical center,Tehran,Iran

Date:2018-19

DECLARATION

This is a consolidated report on comparative study of Followup study comparing open hysterectomy of expert surgeon and laparoscopic approch (learning curve) of the same surgeon based on the cases treated in Imam Hossein Medical center from the period of 01.01.2016 to 31.12.2018. This is submitted to the Singhania University in partial fulfillment of rules and regulations for the Masters in Minimal Access Surgery Examination. This thesis has not been submitted for any other degrees and have no objections for this thesis to be copied in part or whole or used for research purpose.

Professor Maliheh Arab

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Professor Maliheh Arab

ETHICAL COMMITTEE APPROVAL

Proposal entitled ((Followup study comparing open hysterectomy of expert surgeon and laparoscopic approch (learning curve) of the same surgeon)) was approved in 2016 as part of a great research in ethical committee of Shahid Beheshti University of Medical Sciences.

Proforma

Id:

Name:

Age:

Weight:

Height:

BMI:

Medical disease:

Pre-op Hemoglubin:

Post-op Hemoglubin:

Intraoperative Transfusion

Postoperative Transfusion

Operative Time (minutes)

Hospital Stay (days)

Hospital stay complications

Long Term complications

Re-admision

Conversion to laparatomy

Selection criteria for patients:

1- inclusion criteria: women who underwent hysterectomy from 01.01.2016 to 30.12.2018 by laparoscopic or open approach.

2- exclusion criteria: patients with any condition who was necessary to operate just by open method excluded from the study.

Professor Maliheh Arab

RESEARCH PROTOCOL

1. Name of Specialty: Gynecologic Surgery
2. Name of Subject: Open and Laparoscopic Hysterectomy
3. Title of Thesis and Year of Submission: Followup study comparing open hysterectomy of expert surgeon and laparoscopic approch (learning curve) of the same surgeon – 2018
4. Name of Candidate: Professor Maliheh Arab
5. Name of Hospital: Imam Hossein Medical center
6. Sample Size: All the women who underwent hysterectomy by open and laparoscopic approach in Imam Hossein Medical center (2016-2018) by researcher.
7. Study Population: All the women who underwent hysterectomy from 2016-2018.
8. Objectives of study (Aim): comparison of outcome of hysterectomy patients by open or laparoscopic approach with consideration of complications during hospital stay and after discharge, blood transfusion, duration of hospitalization, re-admision and operative time .
9. Materials and Methods:
   a. Study area: Imam Hossein Medical center, Gynecologic department
   b. Study Population: All hysterectomy operations of the researcher in Imam Hossein Medical center from 2016-2018.
   c. Sample Size: 54 cases of Laparoscopic hysterectomy(learning curve) and 54 cases of open hysterectomy of the same surgeon(expert radical surgeon).
10. Data Collection: prospective cohort study
11. Copy of Proforma included.
12. Inclusion Criteria: women who underwent hysterectomy from 01.01.2016 to 30.12.2018 by laparoscopic or open approach.
13. Exclusion Criteria: patients with any condition who was necessary to operate just by open method excluded from the study.

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INTRODUCTION

In minimal access surgery, hysterectomy is among level 4 major procedures. In general, laparoscopic complications are less than open surgery. Issues raised in the early years of laparoscopy in the 1990s compared laparoscopy and laparotomy with hysterectomy showed that laparoscopy was longer. Complications were not different. The duration of hospitalization and recovery was shorter. Many studies suggest that complication rates are inversely proportional to the volume of the surgical work load. During the learning curve, significantly higher major complication rates and longer operative time are observed. Rapidity of learning curve is not significantly related to the surgeon's age, size of practice or hospital setting. Another important factor that affects the learning curve is the supporting surgical team.

In the present study 2 groups of laparoscopic hysterectomy (learning curve) and open hysterectomy by the same surgeon as expert radical surgeon are compared in a cohort followup study.

AIM OF STUDY

Comparison 2 groups of laparascopic hysterectomy (learning curve) and open approach of the same surgeon, as expert-radical Gyneco-oncologist.

REVIEW OF LITERATURE

History of laparoscopy

The first reports of endoscopy are related to hypochondria and rectal examination with spikulum, and air injections have been performed through the tubes. Ileus and intestinal obstruction was known during that period and was treated with minimal invasion. The first use of the light source was by Aranzi in 1585. In 1706 Trochar was defined. In 1806, Mr. Bozzini was able to create a tool to observe the internal organs of the body. In 1853, a French surgeon named Desormeaux used an endoscope, and in 1876 he used alcohol flame for light. In 1868, Kussmaul first saw the digestive tract with an endoscope. In 1869, Pantaleoni, using a modified cystoscope, coughed the uterus bleeding lesion. In this way, Pantaleoni performed the first hysteroscopy. The first practical laparoscopy in Berlin in 1901 was performed by the German surgeon Kelling, who entered the body of dog with a cystoscope and injected the air. In this operation, the filtered air of environment was used to create pneumoperitoneum. In 1910, Jacobaeus of Stockholm wrote an article discussing the peritoneum, pleural, and pericardium views. In 1911,in Johns Hopkins Hospital the first laparoscopic surgery was done and called organoscopy. In 1911, Trochar was used to view the abdomen and thorax. In 1918, Geotze defined the automatic creation of pneumoperitoneum for safe entry into the peritoneal cavity. In 1920, Zollikofer introduced carbon dioxide gas to create pneumoperitoneum instead of filtered air. In 1929, the German physician Kalk defined the diagonal (135 °) diaphragm lens system and a separate entry point for pneumoperitoneum and a needle for air intake. He used laparoscopy and diagnostic method to diagnose liver and gallbladder disease.In 1934, the American surgeon, Ruddock, described the laparoscopic method as a good diagnostic method rather than laparotomy. In 1936, the first laparoscopic tubal ligation was performed by Boesch. In 1938 the Veress Needle was invented and is now widely used to create a pneumoperitoneum. In 1939, Telinde tried to enter the Peritoneum through the coldosac, which later became obsolete. In the same year Kalk published his experiences on more than 2,000 liver biopsies. In 1944, Palmer examined by laparoscopy. In 1953, a rigid lens system was discovered by Hopkins. In the 1960s, the German gynecologist invented the automatic insufflator system, and published his experiences in 1966. In 1960, the English gynecologist introduced the method of sterilization with the two-point puncture method. In 1972, Clarke presented a laparoscopy method for homeostasis. In 1973, Alexander devised local anesthetic procedures for laparoscopy. In 1977, the first laparoscopic appendectomy was done by Dekok. In the same year, Semm showed laparoscopy to endoloop suturing. In 1978, Hasson showed the alternative method of direct insertion of the trochar with direct vision. In 1980, Stepoe began the process of laparoscopy in England. In 1983, Semm performed the first laparoscopic appendectomy.In 1985, the first bile duct surgery was performed by Muhe in Germany. In 1987, the first inguinal hernia repair was introduced with a laparoscope. In 1988 Reich performed laparoscopic lymphadenectomy in cancer treatment. In 1988, Sye performed the first cholecystectomy in the United States. In 1990, Bailey and Zucker in the United

States introduced vagotomy under laparoscopy. In 1994, the first robotic surgery was performed. In 1996, the first telecast laparoscopy was transmitted through the Internet. In 2000, the FDA approved the davinci surgery system. In 2001, lindbergh performed the first transatlantic cholecystectomy surgery with zeus robot. In 2004, the first robotic prostatectomy was performed. In 2005, a combination of coronary artery bypass (CABG) with angioplasty and stenting was reported in Dallas. The goal of minimal access surgery is to minimize damage to the patient without impairment of immunity and the effect of treatment compared to traditional open surgical technique. If this goal is achieved, patients will recover faster, and hospitalization will be reduced, and their return to full activity and work will be returned in a short time(1-32).

The history of laparoscopy is still short and still no long-term results in comparison to open surgery are in our hands(33).

ContraIndications of Laparoscopic surgery

1. Hemodynamic instability
2. Ileus
3. Coagulation disorder
4. Peritonitis
5. Severe pulmonary disease
6. Abdominal wall infection
7. Previous several surgical procedures
8. Late pregnancy

The above items can be considered a relative prohibition and the final decision is with the surgeon(34).

Advantages of laparoscopy

Today there is a lot of evidence of laparoscopic preference, and they all accept it(35). In general, laparoscopic complications are less than open surgery(36). In rectal carcinoma, a traditional open method with laparoscopy was compared. Eighteen patients were randomly and prospectively operated with open and laparoscopic method. The results showed that in laparoscopy surgical time was significantly longer (189 ± 18 vs. 146 ± 22 min), ($P < 0.05$). Postoperative hemorrhage and complications were lower in laparoscopy. Intestinal movement recovery after laparoscopy was faster. The overall complications were 5.6% in the laparoscopic group and 27.8% in the open surgery, which was significant ($P < 0.05$). In the pathologic review of the intestine, the length of resected specimen and the average number of lymph nodes in the laparoscopic group was similar to the open surgery group. The overall conclusion of the study indicated the safety of the method and results comparable to open surgery(37).

All surgeons learn open techniques but experience with laparoscopic techniques is less easily gained—especially when there is pressure to reduce surgical waiting lists. Surgeons with little experience take much longer to complete the procedures and are more likely to make mistakes. This was made clear in a study with a virtual-reality trainer: experienced laparoscopic surgeons far outclassed inexperienced surgeons and novices in speed and accuracy. The practical limitations of laparoscopic surgery are particularly evident with complex operations such as radical prostatectomy. However, once the learning curve has flattened, the results (one-year continence, potency, and positive-margin rates) are comparable with those of retropubic radical prostatectomy.The acquisition of motor skills can be helped by use of special training devices, and development of virtual reality and surgical robots (with tremor filtering) proceeds apace. These advantages will improve the performance of trainees in terms of operating time, error and overall efficiency,though their high cost will limit deployment at least in the short term(33,38-44).

In a study of rectal cancer resection , two laparoscopic and open-label methods were compared. In a prospective randomized study, patients with rectal cancer included 18 patients in the laparoscopic group and 18 patients in the open group. 12-12 Case selection, surgical technique, and clinical and pathological results were reviewed. This study revealed that the operative time was longer in laparoscopic resection group (LAP) than in open resection group (189 ± 18 min *vs* 146 ± 22 min, $P < 0.05$). Intraoperative blood loss and postoperative complications were less in LAP resection group than in open resection group. An earlier return of bowel motility was observed after laparoscopic surgery. The overall postoperative morbidity was 5.6% in the LAP resection group and 27.8% in open resection group ($P < 0.05$). No anastomotic leakage was found in both groups. The pathologic examination showed that the length of the resected specimen, the mean number of harvested lymph nodes in laparoscopic resection group were comparable to those in open resection group. Laparoscopic total mesorectal excision (TME) for rectal cancer is a feasible but technically demanding procedure. The present study demonstrated the safety of the procedure, while oncologic results are comparable to the open surgery, with a favorable short-term outcome(45).

A review of ectopic Pregnancy in Kuwait from 1999 to 2001 including 207 patients conducted to compare laparoscopy and laparotomy in the treatment of ectopic pregnancy surgery. About 184 laparoscopy and 23 laparotomy were performed. Patients who had laparoscopy were successful in 98.9% of cases, and bleeding was significantly lower. Blood transfusion was needed in 13%of the laparoscopic group, comparing to 23% in the laparotomy group. complication did not occur during the surgery in any cases. Duration of surgery was 66 to 72 minutes in both groups. In this study, laparoscopy was superior to laparatomy regarding bleeding and the need for transfusion. Patients needed less pain relief and the duration of post-operative hospitalization was lower.In the xiang study in Shanghai, 72 patients underwent laparoscopic ectopic pregnancy surgery. This study concluded that laparoscopy is more expensive than laparotomy, but the surgical and post operative hospitalization was shorter. In laparoscopic studies, emphasis has been placed on reducing bleeding, hospitalization time, and pain relief need, which are repeated in many studies(46).

In 1999, Laparoscopic hysterectomy was considered alternative for open surgery. Of course, in these years, about 80% of hysterectomies were performed open. In addition, even in countries with sufficient vaginal hysterectomy experience, most hysterectomies, especially if resection of the adnexa is necessary, are performed open. The first laparoscopy was reported in 1989, and then this method continued. In the case of laparoscopic hysterectomy, compared with open surgery, the surgical time is significantly longer. In contrast, looking for pain relief, hospital stay and time to full In 1990 a study compared open and laparoscopic physical activity is less in laparoscopy. hysterectomy. the duration of surgery was longer in laparoscopy, but the duration of hospitalization and recovery was shorter and the complications of the two groups were not different(47-57).

In a study, the time of post-operative recovery and the pain score in 37 patients with primary pelvic pain with diagnosis of fibroma, adenomyosis, and severe endometriosis, who under went LAVH recorded. On the 14th post operative day, patients announced their level of activity at 8.7 out of 10 (in a score of 1-10, the score of 10 has no limit on activity). In another study, people with abdominal hysterectomy had an average uterine weight of 418 grams compared with 150 grams in LAVH cases. The length of hospitalization was 4.5 and 2.5 days after open hysterectomy and LAVH, respectively.LAVH is more expensive than TAH. The issue is whether the benefits of shorter recovery and faster return to work, shorter hospitalization, and less need for pain relief cover the extra cost of laparoscopy. If total health care costs are evaluated, the short-term recovery of laparoscopy, 2 weeks, compared to recovery of 6-8 weeks after open surgery, makes it costly. In LAVH, in order to compare economically with TAH, it saves the cost of disability that can offset more costs. In this regard, insurance companies and hospitals do not share these benefits, and only pay the Therefore, the cost-benefit analysis of both the economic and social aspects must be costs. done in order to make a good decision for the benefit of the patient.It has been shown that TLH and LAVH are associated with shorter hospitalization and patients need less pain relief. LAVH can replace most abdominal hysterectomies due to benign disease. Laparoscopic hysterectomy requires more surgical skills and the learning curve is steep. Studies have shown that laparoscopic advantages comparing to laparotomy include reduced postoperative pain, shorter hospitalization, faster recovery, and faster social recovery. Laparoscopic hysterectomy is longer in all studies. With increasing uterine weight, there is a linear increase in the time and bleeding of hysterectomy. When the size of the uterus is greater than 16 weeks of pregnancy, the time of surgery and bleeding in vaginal hysterectomy is more than the LAVH(58-67).

Laparoscopic Complications

Bleeding complications

These complications may be due to entry into the abdominal cavity or due to trauma to the blood vessels during surgery. Bleeding along with entering the abdomen.

Damage to large vessels

When entering the abdomen, most dangerous bleeding event is damage to the large vessels, including aorta, vena cava, and iliac vessels and its branches. Large vessels damage happens in 0.3 to 9 per 10,000 cases. The most common form of trauma is with insertion of insufflation needle, but it can also be due to the head of trochar damage. Occasionally, damage occurs when secondary ports enter. These vascular injuries are often repairable by suture, and in larger cases they require grafting. Death is also reported in some cases.

Diagnosis

If large vessels are damaged, it is usually characterized by a drop in blood pressure or a significant amount of blood in the peritoneal cavity. Sometimes blood aspirate from the insufflation port before gas entrance. Usually the bleeding is accumulated in the retroperitoneum space, which postpones the diagnosis. In this case, hypovolemic shock may occur in recovery. To prevent delay in diagnosis, it is better to see the pathways of the large vessels before the end of surgery.

Prevention

There are some ways to reduce the probability of the large vessel trauma. The basic issue is placement of the secondary trochars under direct vision. It has been suggested that in open laparoscopy damage to the large vessels is prevented. In general, the correct technique reduces the likelihood of larg vessel trauma. One of the ways to reduce the trauma to the large vessels is to increase the intraabdominal pressure up to 200 mm Hg, although unsuitable for a long time, but helps when inserting trochar.

Large Blood vessel Trauma management

If the blood comes out of the insufflation needle, it should be left in place and immediate blood transfusion and laparotomy is necessary. If the hemoperitomeum is detected through peritoneal cavity, it can be closed by grasping temporarily. In most cases, the surgeon should quickly enter the cavity and immediately push the aorta and vena cava just underneath the renal vessels to control bleeding.

Damage to the abdominal wall vessels

The most common abdominal vessels that are damaged include superior epigastric and inferior epigastric vessels. These vessels are damaged by entry of the trochar. The problem can be detected immediately by observing the blood flow from the cannula or the incision. It is not uncommon for canula to block and stop bleeding itself until the end of surgery when trochar is withdrawn. The most important issue is damage to the deep inferior epigastric vessels, which are the branches of the external iliac artery, rising upwards at the depth of the rectus muscle fascia and deep in the muscle.

Diagnosis of abdominal wall vessel trauma

By observing blood by withdrawal of the cannula, shock after surgery, the abdominal wall discoloration and hematoma close to the insision, abdominal wall vessel trauma is detected . In some cases, blood can be shifted to a more distant location and shows itself as a pararectal or vulvar mass. Late diagnosis can be prevented by examination of each trochar after its departure with laparoscopy.

prevention

With transillumination of the abdominal wall, at least in thin women, superficial inferior epigastric vessels can be identified. With this mechanism, the deep inferior epigastric vessels can not be detected because they are deep in the rectus.

Complications of the gastrointestinal tract

Organs potentially might be affected during laparoscopy include stomach, small intestine and large intestine.

Damage with insufflation needle

Gastrointestinal damage can occur with insufflation needle, which almost always present in cases of gastric distension. However, it is also possible following air swallow or due to inappropriate intubation or anesthesia with mask. Mechanical enterance into the large intestine or small intestine can also occur, but in laparoscopy of cases with previous inflammation of the peritoneum or previous abdominal surgery, is 10 times more common. In these cases, the loops of the intestine can stick to the abdominal wall at the entrance place.

Trochar damage

At the time of Trochar's entry, injury is usually more severe than needle damage. In most cases, the trauma is due to primary trochar injury, but if technique is not good, damage may occur by secondary trochars.

Bladder damage

Bladder and ureteral damage in laparoscopy can be secondary to mechanical or thermal injury. Visceral damage to the bladder is often secondary to full bladder, but can also occur during bladder dissection and adhesion. In cases of urinary incontinence surgery, retropublic suspension might cause bladder injury. Damage to the ureter is secondary to heat injury.

Neurological damage

Neurological damage in laparoscopy is more common in obese women and its prevalence is 0.5 per thousand. Peripheral nerve damage is usually due to inappropriate position of the patient or pressure from the surgeon or assistant. In the lower extremity, trauma can be direct, such as the perineal nerve pressure. Femoral nerve, sciatic nerve or its branches, can be pressed and hurt by unsuitable position of the thigh or knee.

Thermal damage and dissection

Diagnosis of bowel damage that occurs during dissection might be easier. Diagnosis of heat damage to the intestine is more difficult during surgery, especially if it occurs with laser or electricity. Even if thermal damage is detected, it is difficult to detect the extent of injury by observation.

Incisional hernia

This complication is estimated less than actual occurance. In recent studies, hernia after laparoscopy is due to the use of a 10 mm or more port. In our opinion, hernia can be due to increase in operative time, which increases manipulation of the port's location, and the fascia and defect of the peritoneum become larger. Of course, there is chance of hernia in every incision, but diamter of 10 mm or higher is more specific.

Infection

Infection following laparoscopy is less common, but not rare(54,58,68-69).

Training in laparoscopy

The pressure and tendency towards laparoscopy is high. For example, in the United States, many patients insist that their cholecystectomy to perform by laparoscopy. In the United Kingdom, laparoscopy tends to increase as patients are taken into consideration. Of course, the limiting factor is the cost of training and tools. On the other hand, it may be worthwhile in terms of cost-effectiveness as a result of a shorter recovery and fewer complications and a quicker return to work(33). To determine the role of teaching in different laparoscopic surgeries, we will focus on each of them:Special characters of laparoscopic procedures: dependency to instrument, trained staff and prolonged learning curve(70). One of the effective factors in learning is support of the surgical team. One study found that in 87% of laparoscopic cases, technical problems in instruments occure in about 1 to 2 items. For this reason, improvements and standardization of equipment with pre-surgical checklists are recommended(35).

By introducing laparoscopic techniques, many unnecessary complications have been created, leading to clinical trials and box trainer enhancements that accelerate training with animal material or tissues (35,37,47,71-73). A validated, reliable bench model that could train and assess could be standardized and provide numerous benefits including determination of medical students should consider a career in surgery, valuable feedback to residents, a tracking mechanism of resident performance, a possible certification and recertification tool, and to allow for interinstitutional comparison. To this end, several potentially successful bench models testing dexterity, hand-eye coordination, and depth perception have been developed. A few models have been proven to be both valid and reliable indicators of technical skill. Although the future remains uncertain, enough groundwork has been laid to begin incorporating technical skill training and assessment into surgical training programs(74).

The popularity of laparoscopy caused a new approach in surgical training,moving towards learning procedures outside the operating room and far from real patient. Hands-on courses enables novice surgeons to practice techniques on synthetic,porcine or more recently virtual-reality model. The aim has been to ensure trainees are familiar with basic laparoscopic skills, such as hand-eye coordination and depth perception prior to entering the operating room . The success of these courses led to the development of similar courses for the advanced laparoscopic skills (75).

Rasmussen levels of human behavior

Rasmussen distinguishes three levels of human behavior:

1.Skill-based level

2.Rule-based level

3.Knowledge-based behavior

Skill-based Behavior

This represents surgeon's behavior that takes place without conscious control. Task execution is automated at this level of behavior and is based on fast selection of motor programs which control the appropriate muscles. The motor programs are based on an accurate internal representation of the task, the system dynamics, and the environment at hand (e.g. learned by training and experience). An example of an everyday skill is walking. Many tasks in surgery can be considered as a sequence of skilled acts. For example, an experienced surgeon performs a suture task smoothly, without conscious control over his or her movements. In MIS, suturing can also be considered as skill-based behavior. However, because of the indirect access to the tissue, it is a much more complicated skill because of reduced depth perception and difficult hand-eye coordination(75).

Rule-based Behavior

At the next level of human behavior, rule-based behavior is applied. During rule-based behavior task execution is controlled by stored rules or procedures. These may have been derived empirically from previous occasions or communicated from other persons' expertise as instructions or as a cookbook recipe. Appropriate rules are selected according to their ''success'' in previous experiences. For example, procedural steps and the recognition of anatomy and pathology in MIS require rule-based behavior. At the rule-based level, the information is typically perceived as discrete signs. A sign serves to activate or to trigger a stored rule. Stopping car in front of a red light is a good example of a sign (red light) that triggers a stored rule (stop car)(75).

Knowledge-based Behavior

In unfamiliar situations, faced with a task for which no rules are available from previous encounters, human behavior is knowledge-based. During knowledge-based behavior the goal is explicitly formulated, based on an analysis of the overall aim. Different plans are developed, and their effects mentally tested against the goal. Finally a plan is selected. Serious complications that occasionally occur during surgery demand a great deal of knowledge-based behavior from the surgeon .He or she has to analyze the complication and the aim of the surgical procedure in order to develop strategies to counter the complication. Then he or she has to select the best strategy and consequently take the appropriate actions. At the knowledge-based level, information is perceived as symbols. Symbols refer to chunks of conceptual information, which are the basis for reasoning and planning. Pathological symptoms are a good example of symbols in medical practice. Training in laparoscopic surgery is beginning to evolve into a stepwise, curricular approach that is not organ or procedure-specific. Instead, it is necessary to learn manipulative skills, which are then combined to achieve proficiency in tasks such as laparoscopic suturing or division of a vessel. The constituent parts can then be combined with anatomical knowledge to enable completion of a specific procedure. Basic psychomotor skills can be learnt with a simple, cheap version of a video-box trainer. Higher level skills such as dissection and use of high-energy instruments will necessitate the use of more realistic tissues,which can be achieved on porcine or human cadaveric models. Recent advances in virtual reality simulation are also beginning to produce realistic simulations of complete procedures (75).

TRAINING—OBJECTIVES, NEEDS, AND MEANS

To enable the design and evaluation of an effective and efficient training method it is of utmost importance to determine the training objectives, needs, and means, since they provide an answer to the questions:

1. What is the end goal of the training?
2. What should be trained?
3. How can we train it?

The objectives represent the level of competence that is expected of the trainee after he or she has completed the training. Training needs are the difference between the initial level of competence of the trainees and the required level of competence after successful completion of the training defined in the objectives. Ultimately, demands for effectivity and efficiency on the one hand, and the state-of-the-art in technology on the other hand, determine the tools and methods for training, i.e. the training means. Since safety and patient outcome are the most important criteria in surgery, training effectivity should be of primary importance The complexity and the costs of the training means are largely determined by the training objectives that have been set. Fulfilling all training needs of laparoscopic residents with only one training method will require a highly complex and probably very expensive trainer in which all three levels of behavior can be trained. Such a trainer is not yet available.

PRESENT TRAINING IN LAPAROSCOPY

A closer look at the training program of laparoscopic residents provides an indication of the training needs that are addressed and the training means that are available today. Much as in conventional surgery, the laparoscopic surgeon must effectively combine the three levels of behavior. Instrument handling and dissection techniques require skill-based behavior, whereas the recognition of surgical anatomy requires a great deal of rule-based behavior. Complications such as uncontrollable bleeding or unsuspected situations such as the encountering of aberrant anatomy require problem solving on a knowledge-based level. Obviously, training of skill-based behavior in laparoscopic surgery is highly desired as laparoscopy combines unusual hand-eye coordination with the use of complex instruments. Surgical residents are usually trained in laparoscopic surgery during a 2 days introduction course. Basic skill-based behavior such as instrument tissue handling and minimally invasive suturing are trained. Additionally, rule-based behavior is trained through lectures, textbooks, and video instructions. After the resident has successfully completed this course, he or she will receive training in the operating room. It is only in operating room that most knowledge-based behavior necessary to deal with complications and emergencies is acquired. Currently, a living animal model provides the only way to effectively train rule- and knowledge-based behavior outside the operating room. Training on living animal models is very useful in the training curriculum of resident surgeons. However, at the same time the use of laboratory animals for training is discouraged by many government policies. Technological innovations, such as virtual reality simulation, will change the way laparoscopic surgery is trained. Current accomplishments in surgical simulation envision the dawning of the next-generation surgical education. In this respect, aviation industry provides excellent examples of the virtual reality simulators as a means of training. However,performing safe laparoscopy also requires a professional level of rule- and knowledge-based behavior from the surgeon. Ideally these should also be trained outside the operation theatre. Currently, the training of rule- and knowledge-based behavior outside the operation theatre is only possible on living animal models. The medical society should establish detailed objectives of training. Recently, experts have begun to investigate what level of professional behavior is required to perform safe laparoscopy. In addition, they are establishing the training needs of laparoscopic residents by determining what should be trained to accomplish the training objective. The question of which aspects of skill, rule, and knowledge-based behavior should be trained is addressed. Currently, there is no such standard available. Once the training objectives have been standardized and the training needs at the different levels of behavior have been identified, the simulator society will have clear guidelines as to what their training devices should be capable of. One of the most obvious training needs of laparoscopic residents is the training of manual skills. The manual skills required during laparoscopy are rather different from those in conventional surgery. Training of skill-based behavior is feasible with basic trainers such as a pelvitrainer. The VR basic skill trainers that are commercially available usually simulate a generic abdomen and endoscopic instruments on a computer monitor. Basic tasks, such as pick and place tasks, are implemented to train endoscopic manipulation. The training of skill-based behavior does not require a highly realistic anatomical environment, e.g. the organs do not necessarily have to be simulated realistically. For example, the virtual reality trainer simulates basic manipulation tasks in a highly simplified environment similar to the pelvitrainer box. Several studies have reported that training on the virtual reality facilitated the learning of skill-based behavior(41,43,75-121).

learning curve in laparoscopy

learning curve steps in surgery and laparoscopy

Stages of a learning curve

it is generally accepted that learning consists of an initial phase of relatively rapid learning followed by a phase of diminishing returns(122).

The initial curve

The routine of learning is the active learning with feedback. Usually, with increasing experience, learning progressively slows down to a plateau. In fact, it takes time to acquire the skill level.

Complications involved in learning include:

1. Technology change
2. Feedback and guide lines
3. Experience of the surgical team
4. Surgeon's personal profile including attitude, motivation and new learning power(71,122-125).

The 'expert plateau'

A plateau actually means the termination and slowdown of learning and the need for a replacement or new educational method. In practice, the stage of competence involves several factors, including recognition, the fields of integration and communication(122,126-127).

The decline of competency

Two common types of competency reduction

1. A transient drop that occurs with a short distance from plateau and is usually due to high self-esteem, and undertaking more complicated cases.

2. Amnesia that occurs with a long time and Part of it can be due to age.

In Canada, India and Ireland, retirement age is 65 years and in Russia and China 60 years. Physiological decline with age in the cognitive and motor function necessary for surgery should be considered. There is little information about the specific relationship between the surgeon's age and the outcome of the patient(122,124,128-131).

learning curve has four main phases. The starting coordinate A, represents commencement of training. Secondly, the curve ascends. The gradient of this ascent indicates how quickly the individuals, erformance improves; this part of the curve may be a stepwise ascent as individuals learn and master stages of a complex procedure. Improvements in performance tend to be most rapid at first and then tail off, as the degree of improvement attained with each case reduces as technique is refined. Thirdly, assuming adequate aptitude, a point is reached when the procedure can be performed independently and competently (coordinate B). Additional experience improves outcomes by small amounts coordinate C), until a plateau, or asymptote, is reached (coordinate D). Fourthly, with advancing age, manual dexterity, eyesight, memory and cognition may deteriorate, outweighing any advantage derived from long experience, leading to a fall in the level of performance (coordinate E).9 10 An alternative curve has also been described (dotted line),11 which exhibits temporary performance deterioration after technical competence has been achieved. The reasons postulated are case mix effect (undertaking more difficult cases), or over confidence resulting in lapses in technique or judgement(124,132-134).

THE STEEP LEARNING CURVE MISNOMER

A procedure with difficult and complex steps is often termed as having a steep learning curve, and certainly in mountaineering terms steepness usually equates to difficulty. However, steepness can equally relate to climbing and gaining height rapidly. Similarly, it may be argued that a steep learning curve implies that skills are acquired rapidly, usually because the procedure is simple. Complicated and technically demanding procedures are often described erroneously as having a steep learning curve, which implies large improvements in outcomes are achieved early in a case series, and competence (coordinate B) is achieved after relatively short experience. In fact, complex procedures are more likely to have gradual learning curves, with small improvements in outcome associated with each passing case, such that coordinate B is achieved only after large experience or not at all(124). Learning curves are a graphical representation of the relationship between learning effort and learning outcome. Learning curves were first used in industry to describe how the number of man-hours required to build an aircraft decreased as the quantity of production increased.In medicine, learning curves were used in the 1980s to describe the uptake of new surgical skills for minimally invasive surgery.Learning curves are increasingly being used in various aspects of medicine including research and healthcare education,randomised controlled trial design, training programme design and assessment of surgical performance(128,135-141).

Although learning is a complex function of experience, the task at hand and individual characteristics, it is generally accepted that learning consists of an initial phase of relatively rapid learning followed by a phase of diminishing returns. Intricate tasks may also exhibit a subsequent unlearning (or forgetting) phase.

More about the initial curve

Each surgeon’s prior experience and background are different, resulting in varying initial levels of performance. The usual method of learning is by active learning with feedback. Generally, a stepwise improvement in learning outcome occurs, although this is often masked by the high variability of surgical data. Based on the theory of deliberate practice, learning occurs at a progressively slower rate as an operator becomes increasingly competent at a skill, eventually reaching an expert plateau. Clinicians often (wrongly) use the term ‘steep learning curve’ to describe a procedure that is difficult to learn. In fact, what they mean is that competence takes time to achieve. In the context of learning curves, ‘steep’ should imply rapid learning (large gradient) which is usually associated with easy-to-learn tasks. Many factors influence an individual’s learning curve. External factors include changes in chnology and the introduction of guidelines. The experience and consistency of the surgical team can also influence the surgeon’s learning. Finally, surgeon-specific characteristics such as attitude, natural talent, motivation, previous experience and the ability to learn new skills will all strongly affect the rate of learning(71,123-125).

More about the ‘expert plateau’

An ‘expert’ and ‘expert performance’ are difficult to define.Reaching a plateau does not qualify a surgeon as an expert or mean expert performance has been reached. A plateau may instead indicate termination or retardation of learning and the need for alternative or additional educational strategies to be employed. In practice, competence encases several components such as cognitive, integrative, affective and communicational domains. Few studies assess competence using such a holistic approach. The literature regarding the definition and measuring of competence is still poor(126-127).

More about the decline of competency

There are two common types of reduction of surgical competency. The first is a temporary decline in performance that occurs soon after the expert plateau has been reached. This is usually due to overconfidence or surgeons undertaking more challenging operations. The second is forgetting or ‘unlearning’. This occurs after a length of time spent at an expert plateau and can be detected through continual learning data analysis (particularly if considered for appraisal). Part of this decline can be attributed to the physiological effects of ageing. This is recognised in Canada, India and Ireland where doctors have a mandatory retirement age of 65 years and in Russia and China where the retirement age is 60 years. Reforms to the NHS pension scheme means surgeons may need to work until 68 years of age.It follows that the physiological decline with ageing of cognitive and motor skills required in surgery needs to be monitored. Little is known about the exact relationship between surgeon age and patient outcome measures, mainly because of the use of surrogate markers for postoperative outcome(124,128-131).

Learning outcome

(y-axis) can be represented by surgical process (usually continuous variables such as operative time and intraoperative blood loss) and patient outcome variables (usually dichotomous variables such as postoperative complications and survival). In the literature, 'operative time' is the most commonly used variable for learning outcome. Although this variable is easy to obtain from an operative database, it is a relatively weak proxy for learning and its definition often varies (eg, 'incision-to-closure' vs 'incision-to-dressing'). Other learning outcome variables also face validity issues. Rare, dichotomous events such as complications are difficult to analyse statistically. Operative mortality may not be a suitable outcome measure for low-risk procedures while cancer surgery outcomes are best represented by long-term outcomes(124,136,142).

DEFINITION AND DESCRIPTION

For the Wright learning curve, the underlying hypothesis is that the direct man-hours necessary to complete a unit of production will decrease by a constant percentage each time the production quantity is doubled. In manufacturing, the learning curve applies to the time and cost of production. Can a surgeons learning curve be described on similar lines? A simple definition would be : the time taken and/or the number of procedures an average surgeon needs to be able to perform a procedure independently with a reasonable outcome.1 But then who is an average surgeon ? Another definition may be that a learning curve is a graphic representation of the relationship between experience with a new procedure or technique and an outcome variable such as operation time, complication rate, hospital stay or mortality. A learning curve may also be operationally defined as an improvement in performance over time. Although learning theorists often disagree about what learning is, they agree that whatever the process is, its effects are clearly cumulative and may therefore be plotted as a curve. By cumulative it is meant that somehow the effects of experience carry over to aid later performance. This property is fundamental to the construction of learning curves. The improvement tends to be most rapid at first and then tails off. Hence there are three main features of a learning curve. First, the initial or starting point defines where the performance of an individual surgeon begins. Secondly, the rate of learning measures how quickly the surgeon will reach a certain level of performance and thirdly the asymptote or expert level measures where the surgeons performance stabilizes. This has implications for the laparoscopic surgeon—it suggests that practice always help improve performance but the most dramatic improvement happens first. Also with sufficient practice surgeons can achieve The multimode learning curve is useful because several factors comparable levels of performance. can be put into one graph. The earlier used method of the performance analysis with its on the spot appraisals at certain time intervals has been replaced by continuous assessment. For continuous data Many studies suggest that complication like operation time the Moving average method is useful. rates are inversely proportional to the volume of the surgical workload. However rapidity of learning is not significantly related to the surgeons age, size of practice or hospital setting. Another important factor that affects the learning curve is the supporting surgical team. A recent observational study to investigate the incidence of technical equipment problems during laparoscopic procedures reported incidents with technical equipment or instruments occurred. that in 87% of procedures one or more Hence improvement and standardization of equipment combined with incorporation of check lists to be used before surgery has been recommended(35,125,143-147).

In various surgeries, depending on the difficulty of the surgical operation, learning curve with a number of patients is determined to reduce the complications and the time of surgery near to the similar open surgical procedure(36).

LEARNING CURVE IN LAPAROSCOPY

TP Wright originally introduced the concept of a learning curve in aircraft manufacturing in 1936. He described a basic theory for costing the repetitive production of airplane assemblies. The term was introduced to medicine in the 1980s after the advent of minimal access surgery. It also caught the attention of the public and the legal profession when a surgeon told a public enquiry in Britain that a high death rate was inevitable while surgeons were on a learning curve. Recently, it has been labeled as a dangerous curve with a morbidity, mortality and unproven outcomes. Yet there is no standardization of what the term means. In an endeavor to help laparoscopic surgeons towards evidence based practices, this commentary will define and describe the learning curve, its drawing followed by a discussion of the factors affecting it, statistical evaluation, effect on randomized controlled trials and clinical implications for both practice and training, the limitations and pitfalls, ethical dilemmas and some thoughts to pave the way ahead.

THE DRAWING OF LEARNING CURVES

There are a variety of methods of constructing learning curves. They all assume that successive exposures in a learning series may be plotted on the X-axis, response characteristics on Y-axis and the data points distributed in the XY plane may be legitimately connected by a curve. This is the Cartesian method. More recently, the cumulative sum method has been applied for the construction of these curves for basic skills in anesthetic procedures—the method consists of relatively simple calculations that can be easily performed on an electronic spreadsheet.

Statistical inferences can be made from observed success and failure. The method also provides both numerical and graphical representation of the learning process. The multimode learning curve is useful because several factors can be put into one graph. The earlier used method of the performance analysis with it's on the spot appraisals at certain time intervals have been replaced by continuous assessment. For continuous data like operation time the moving average method is useful.

FACTORS AFFECTING LEARNING CURVES

Complex hierarchies of factors are involved here (Fig 1) Factors like guidelines, protocols and standards for clinical governance agreed upon by the medical fraternity are vital. Next, the institutional policies and cost effectiveness are contributory. Needless to say the surgical team, the case mix and public awareness are relevant. The final level in the hierarchy that can influence individual learning is the characteristics of the surgeon such as attitude, capacity for acquiring new skills and previous experience.

Amongst the latter, that is the characteristics of the surgeon, the learning curve may depend on the manual dexterity of the individual surgeon and the background knowledge of surgical anatomy. The type of training the surgeon has received is also important as training on inanimate trainers and animal tissue has been shown to facilitate the process of learning. The slope of the curve depends on the nature of the procedure and frequency of procedures performed in specific time period. Many studies suggest that complication rates are inversely proportional to the volume of the surgical workload. However, rapidity of learning is not significantly related to the surgeon's age, size of practice or hospital setting. Another important factor that affects the learning curve is the supporting surgical team.

A recent observational study to investigate the incidence of technical equipment problems during laparoscopic procedures reported that in 87 percent of procedures one or more incidents with technical equipment or instruments occurred. Hence, improvement and standardization of equipment combined with incorporation of check lists to be used before surgery has been recommended.

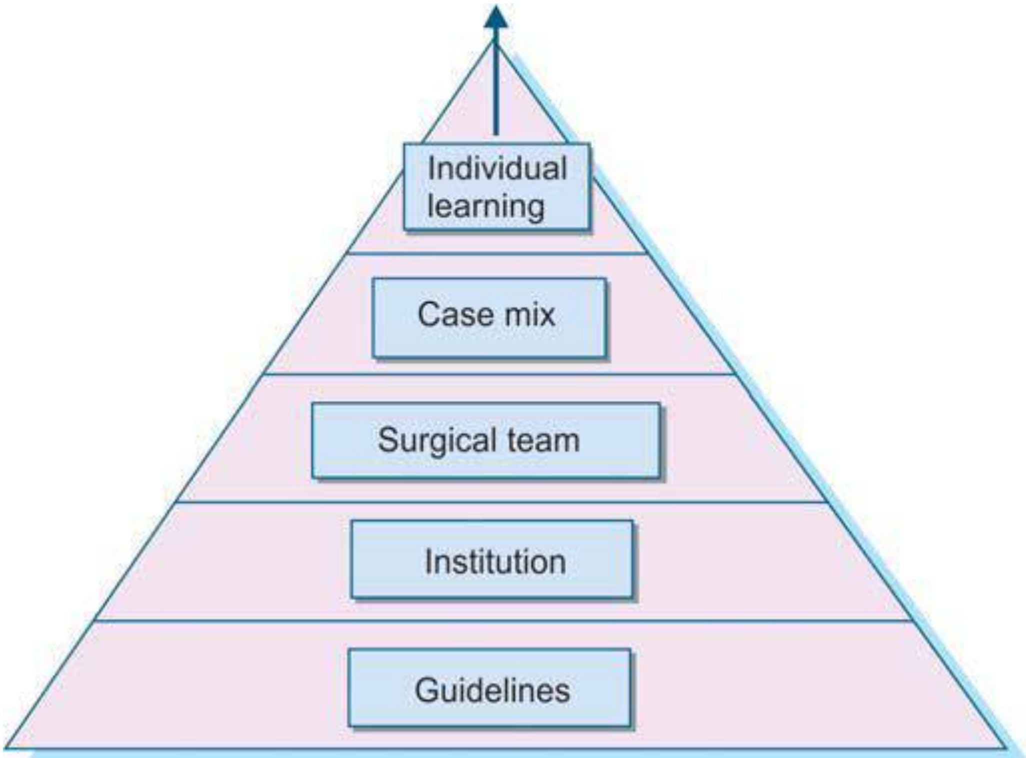

Fig.1: Hierarchy of factors affecting learning curve (from Textbook of Practical Laparoscopic Surgery RK Mishra with permision)

STATISTICAL EVALUATION OF LEARNING CURVES

Various statistical methods have been reported in the assessment of the learning curve. Commonly data are split into arbitrary groups and the means compared by chi squared test or ANOVA. Some studies had data displayed graphically with no statistical analysis. Others used univariate analysis of experience versus outcome. Some studies used multivariate analysis techniques such as logistic regression and multiple regression to adjust for confounding factors. A systematic review concluded that the statistical methods used for assessing learning curves have been crude and the reporting of studies poor. Recognizing that better methods may be developed in other nonclinical fields where learning curves are present (psychology and manufacturing) a systematic search was made of the nonclinical literature to identify novel statistical methods for modeling learning curves. A number of techniques were identified including generalized estimating equations and multilevel models. The main recommendation was that given the hierarchical nature of the learning curve data and the need to adjust for covariant, hierarchical statistical models should be used.

EFFECT OF LEARNING CURVE ON RANDOMIZED CONTROLLED TRIALS

The learning curve can cause difficulties in the interpretation of RCTs by distorting comparisons. The usual approaches to designing trials of new surgical techniques has been either to provide intensive training and supervision or require participating surgeons to perform a fixed number of procedures prior to participation in a trial. Surgeons have been reluctant to randomize until they are proficient in a technique but once convinced of its worth, argue that it is too late to randomize. However, the best way to address the problem is to have a statistical description of the learning curve effect within a trial and various methods can then be used example Bayesian hierarchical model.

IMPLICATIONS FOR PRACTICE AND TRAINING

In the current era of evidence based medicine enthusiasm for laparoscopic surgery is rapidly gaining momentum. There is an immense amount of literature showing advantages of minimal access surgery and acceptance by the public. The learning curve for many procedures has been documented. As far as training is concerned, the introduction of laparoscopic techniques in surgery led to many unnecessary complications. This led to the development of skills laboratories involving use of box trainers with either innate or animal tissues but lacks objective assessment of skill acquisition. Virtual reality simulators have the ability to teach psychomotor skills. However, it is a training tool and needs to be thoughtfully introduced into the surgical training curriculum. A recent prospective randomized controlled trial showed that virtual simulator combined with inanimate box training leads to better laparoscopic skill acquisition. An interesting finding reported is that in skills training every task should be repeated at least 30 to 35 times for maximum benefit. The distribution of training over several days has also been shown to be superior to training in one day. Other factors enhancing training are fellowship programmer, or playing video games. One can also obtain feedback for improvement of training program. In one such study, the deficiency factors identified were lack of knowledge, lack of synchronized movement of the nondominant hand and easy physical fatigue. Incorporation of intensive, well planned in vitro training into the curriculum was made and the programmed reassessed.

WHAT ARE THE LIMITATIONS OR PITFALLS?

"Steep" learning curves are usually used to describe procedures that are difficult to learn. However, this is a misnomer as it implies that large gains in proficiency are achieved over a small number of cases. Instead the curve for a procedure that requires a lot of cases to reach proficiency should be described as "flattened." As long as no valid scoring system concerning the complexity of a surgical intervention exists, the learning curve cannot be used as benchmarks to compare different surgeons or clinics as legitimate instruments to rank surgeons or different hospitals. Limitations of long learning curves, facilities for training, mistakes of pioneers, surgical techniques not being described in books are some of the limitations.

There are other limitations due to the nature of laparoscopic surgery like the lack of 3D vision and of tactile sensations, difficult hand eye coordination and long instruments.

ETHICAL DILEMMAS

Many dilemmas exist and many questions will always be with us—who bears the burden of the learning curve? Are the patients aware of the risks? Many reports validate the impression that a patient operated upon during the learning curve takes greater risks and incurs more adverse circumstances than the patient operated upon later. The issue of how informed the informed consent should be needs to be addressed. Is the integrity and conscience of a surgeon measurable? Should the forces of marketing be curtailed or regulated?

THE WAY FORWARD

Laparoscopic surgery is here to stay and success in it is determined by how quickly and effectively we learn. However, certain measures may be taken to lessen some of the adverse effects of the learning curve and others to help laparoscopic surgeons ease into the specialist. Setting up of minimal standards and credentialing is a must. Current guidelines in many countries are vague and general. The evidence for training is well documented. The message for individual surgeons is to identify their deficiencies, and chart a way forward for their personal graph of progress.

Evaluation and monitoring in a systematic scientific manner will benefit the surgeon with a satisfactory learning curve that will ensure that patient welfare is not compromised.

It has been concluded that it is important to establish the training objectives, needs, and means, since they provide an answer to the questions. What is the endgoal of the training?, What should be trained?, and How can we train it? Rasmussen's model of human behavior provides a practical framework for the definition of the training objectives, needs, and means in MIS, and the evaluation thereof(41,43,75-121).

Training in laparascopy is copied from Mishra RK. Text book of Practical Laparoscopic Surgery: in chap 46, by premission.

LRYGBP (Laparoscopic Roux-en-Y Gastric Bypass) surgery has a long learning curve with about 75-100 patients, within these period longer duration of surgery and more complications are observed(47).

In a survey of esophageal cancer, a surgeon was studied and his patients were studied up to 150 cases, divided into 5 groups of 30, all of them were the same regarding age, Surgery, Weight Loss, Grade of American Society of Anesthesiologists, Stage and grade of Disease. Data analysis revealed a significant improvement in terms of reduction of surgical time (P = 0.01), decreased bleeding (P = 0.03), decreased blood transfusion requirement (P <0.0001), hospitalization in ICU (P <0.0001), Decreased hospital stay and increased number of lymph nodes (P <0.0001). This study confirmed improvement of the surgeon's performance during the 7-year period. Today, with the supervision of a trained and experienced person in the specialized unit, this course of learning becomes shorter(148).

Learning curve is defined in many surgical procedures(35). In laparoscopic gastric bypass surgery, a study on patients revealed in the learning period up to 75 patients, higher morbidity and longer surgical duration. We have previously shown that the learning curve for a surgeon skilled in advanced laparoscopy is approximately 75 operations.1 During the learning curve, we demonstrated significantly higher major complication rates and significantly prolonged operative times.1 Others have shown a similar learning curve effect. Schauer et al2 reported elevated complication rates and prolonged operative times over their initial 100 LRYGBP procedures(36). A laparoscopic appendectomy (50 patients) was compared with open appendectomy (53 patients). Learning curve for laparoscopic appendectomy was 30 patients. Surgery time and complications in the laparoscopic group and open surgery were not different. In 50 patients, laparoscopy was divided into two groups in the learning curve and after the learning curve group. The mean time in the learning group was 66.83 ± 21.51 and the second group was 45.25 ± 19.10, respectively. (p <0.0001) There was no difference in the surgical complications between the two groups of learning and after the learning(149).

In a survey, laparoscopic vascular colorectal patients were studied. A total of 461 consecutive resections were evenly distributed among three surgeons (141, 155, and 165). Median operating time was 180 minutes for Cases 1 to 30 in each surgeon's experience and declined to a steady state (150-167.5 minutes) for Cases 31 and higher. Subsequently, Cases 1 to 30 were considered "early experience," whereas Cases 31 and higher were combined as "late experience" for statistical analysis. There were no significant differences between patients undergoing resections in the early experience and those undergoing resections in the late experience with respect to age, weight, or proportion of patients with malignancy, diverticulitis, or inflammatory bowel disease. There were greater proportions of males (42 vs. 54 percent, P = 0.046) and rectal resections performed (14 vs. 32 percent, P = 0.002) in the late experience. Trends toward declining rates of intraoperative complications (9 vs. 7 percent, P = 0.70) and conversion to open surgery (13.5 vs. 9.7 percent, P = 0.39) were observed with experience. Median operating time (180 vs. 160 minutes, P < 0.001) and overall length of postoperative hospital stay (6.5 vs. 5 days, P < 0.001) declined significantly with experience. There was no difference in the rate of postoperative complications between early and late experience (30 vs. 32 percent, P = 0.827). In conclusion, the learning curve for performing colorectal resections was approximately 30 procedures in this study, based on a decline in operating time, intraoperative complications, and conversion rate. Learning was also extended to clinical care because it was appreciated that patients could be discharged to their homes more quickly(73).

In a study, learning curve of a laparoscopic colorectal surgery was studied. Study revealed the conversion rate for right-sided colonic resections was 8.1% (*n* _ 457) compared with 15.3% for left-sided colorectal resections (*n* _ 443). Independent predictors of conversion of laparoscopic to open surgery were the body mass index (BMI) (odds ratio _OR_ _ 1.07 per unit increase), ASA grade (OR _ 1.63 per unit increase), type of resection (left colorectal versus right colonic procedures, OR _ 1.5), presence of intra-abdominal abscess (OR 5.0) or enteric fistula (OR 4.6), and surgeon's experience (OR 0.9 per 10 additional cases performed). Having adjusted for case-mix, the CUSUM analysis demonstrated a learning curve of 55 cases for right-sided colonic resections versus 62 cases for left-sided resections. Median operative time declined with operative experience (*P* _ 0.001). Readmission rates and postoperative complications remained unchanged throughout the series and were not dependent on operative experience. In conclusion, conversion rates for laparoscopic colectomy are dependent on a multitude of factors that require appropriate adjustment including the learning curve (operative experience) for individual surgeons. The laparoscopic model described can be used as the basis for performance monitoring between or within institutions. In a survey of colorectal laparoscopy, the learning curve was studied. The learning curve for right colon was 55 cases and the left colon was 62. Median operative time declined with operative experience (*P* _ 0.001). Readmission rates and postoperative complications remained unchanged throughout the series and were not dependent on operative experience. Conversion rates for laparoscopic colectomy are dependent on a multitude of factors that require appropriate adjustment including the learning curve (operative experience) for individual surgeons. The laparoscopic model described can be used as the basis for performance monitoring between or within institutions.However, we did not demonstrate a reduction in the readmission rate and complication rate with increasing experience despite a significant reduction in the operating time and conversion rate. The possible explanation for this paradox is the significant shift toward more complex and highrisk cases in the later part of the series, thus resulting in an overall stable complication and readmission rate. Similar findings were reported by Marusch et al21 in a multicenter study of 1658 patients, which showed that surgeons with experience of more than 100 laparoscopic colorectal operations were more likely to embark on more difficult cases with a conversion rate of 4.3% versus 6.9% for surgeons with experience of less than 100 procedures yet identical postoperativemortality and morbidity between the 2 groups(150).

In a study, the effect of Fellowship Training on LRYGBP SURGERY LERINGING CURVE was investigated(36).Age, BMI, and gender distribution were similar in both groups. Operative time was significantlylonger in Group B (189 min. vs 122 min., *P*<0.05).The mean operative time in Group A (122 minutes) was 67 minutes less than the mean operative time in Group B (188 minutes) (Table 2). This difference was statistically significant (*P*<0.05).(The study population consisted of two groups of 75 patients. Each group was comprised of the initial 75 LRYGBP operations attempted by one of two surgeons. One surgeon (Group A) was LRYGBP fellowship trained and the other surgeon (Group B) was not LRYGBP fellowship trained. We compared groups of 75, because we previously demonstrated that the learning curve for LRYGBP is approximately 75 procedures(36).

We have previously shown that the learning curve for a surgeon skilled in advanced laparoscopy is approximately 75 operations.1 During the learning curve, we demonstrated significantly higher majorcomplication rates and significantly prolonged operative times.1 Others have shown a similar learning curve effect. Schauer et al2 reported elevated complication rates and prolonged operative times over their initial 100 LRYGBP procedures(36,151-152).

In a study, laparoscopic learning curves were investigated in colorectal surgery.Having adjusted for case-mix, the CUSUM analysis demonstrated a learning curve of 55 cases for right-sided colonic resections versus 62 cases for left-sided resections. Median operative time declined with operative experience (*P* _ 0.001). Readmission rates and postoperative complications remained unchanged throughout the series and were not dependent on operative experience. Conversion rates for laparoscopic colectomy are dependent on a multitude of factors that require appropriate adjustment including the learning curve (operative experience) for individual surgeons. The laparoscopic model described can be used as the basis for performance monitoring between or within institutions. The median operating time for the first 25 procedures was 180 minutes (range, 60–430 minutes) and was longer in comparison with all other groups of operative experience (Fig. 4). Median operating time at the end of the series (_175 cases) was 115 minutes (range, 35–490 minutes). On multivariate analysis of covariance, having adjusted for the risk factors that affected operating time (patient age: $F_{1,823}$ _ 8.823, *P* _ 0013; BMI: $F_{1,823}$ _ 6.405, *P* _ 0.012; and gender: $F_{1,823}$ _ 7.362, *P* _ 0.007), a statistically significant difference in operating time (ie, reduction) was demonstrated with increasing operative experience ($F_{7,823}$ _ 10.030, *P* _ 001). There was no significant difference in the operating time between rightsided and left sided resections (*P* _ 0.115). However, we did not demonstrate a reduction in the readmission rate and complication rate with increasing experience despite a significant reduction in the operating time and conversion rate. The possible explanation for this paradox is the significant shift toward more complex and highrisk cases in the later part of the series, thus resulting in an overall stable complication and readmission rate. Similar findings were reported by Marusch et al[21] in a multicenter study of 1658 patients, which showed that surgeons with experience of more than 100 laparoscopic colorectal operations were more likely to embark on more difficult cases with a conversion rate of 4.3% versus 6.9% for surgeons with experience of less than 100 procedures yet identical postoperative mortality and morbidity between the 2 groups(150).

In the study of laparoscopic appendectomy learning curve by inclusive: There were no differences in the operative times (A, 64.15 ± 29.88 minutes; B, 58.2 ± 20.72 minutes; P-value, 0.225) and complications (A, 11%; B, 6%; P-value, 0.34) between group A and group B. Group B was divided into group C who underwent the operation in the early period (before the learning curve) and group D who underwent the operation in the later period (after the learning curve). The average operative time for group C was 66.83 ± 21.55 minutes, but it was 45.25 ± 10.19 minutes for group D (P-value < 0.0001). Although this difference was statistically significant, no significant difference in the complication rate was observed between the two groups. In Conclusion, a laparoscopic appendectomy, compared with an open appendectomy, performed by a surgical trainee is safe. In this study, the learning curve for a laparoscopic appendectomy was thirty cases(153).

In a study, the learning curve was determined for laparoscopic colorectal resection.A prospectively accumulated, computerized database of all laparoscopic colorectal resections performed by three surgeons between April 1991 and March 1999 was reviewed. A total of 461 consecutive resections were evenly distributed among three surgeons (141, 155, and 165). Median operating time was 180 minutes for Cases 1 to 30 in each surgeon's experience and declined to a steady state (150-167.5 minutes) for Cases 31 and higher. Subsequently, Cases 1 to 30 were considered "early experience," whereas Cases 31 and higher were combined as "late experience" for statistical analysis. There were no significant differences between patients undergoing resections in the early experience and those undergoing resections in the late experience with respect to age, weight, or proportion of patients with malignancy, diverticulitis, or inflammatory bowel disease. There were greater proportions of males (42 vs. 54 percent, $P = 0.046$) and rectal resections performed (14 vs. 32 percent, $P = 0.002$) in the late experience. Trends toward declining rates of intraoperative complications (9 vs. 7 percent, $P = 0.70$) and conversion to open surgery (13.5 vs. 9.7 percent, $P = 0.39$) were observed with experience. Median operating time (180 vs. 160 minutes, $P < 0.001$) and overall length of postoperative hospital stay (6.5 vs. 5 days, $P < 0.001$) declined significantly with experience. There was no difference in the rate of postoperative complications between early and late experience (30 vs. 32 percent, $P = 0.827$). In conclusion,The learning curve for performing colorectal resections was approximately 30 procedures in this study, based on a decline in operating time, intraoperative complications, and conversion rate. Learning was also extended to clinical care because it was appreciated that patients could be discharged to their homes more quickly(73).

Comparing resection of rectal cancer in open and laparoscopic groups: The operative time was longer in laparoscopic resection group (LAP) than in open resection group (189 ± 18 min *vs* 146 ± 22 min, $P < 0.05$). Intraoperative blood loss and postoperative complications were less in LAP resection group than in open resection group. An earlier return of bowel motility was observed after laparoscopic surgery. The overall postoperative morbidity was 5.6% in the LAP resection group and 27.8% in open resection group ($P < 0.05$). No anastomotic leakage was found in both groups. The pathologic examination showed that the length of the resected specimen, the mean number of harvested lymph nodes in laparoscopic resection group were comparable to those in open resection group. In conclusion,laparoscopic total mesorectal excision (TME) for rectal cancer is a feasible but technically demanding procedure. The present study demonstrates the safety of the procedure, while oncologic results are comparable to the open surgery, with a favorable short-term outcome(154).

In the study of learning curves in laparoscopic colorectal surgery:laparoscopic colorectal surgery has been used for inflammatory, benign and malignant disease entities and has been shown to reduce postoperative pain and length of hospital stay, provide faster recovery, and shown to be cost-effective in comparison to open surgery(150,155).

A study was conducted to determine the learning curve in colorectal surgery. A total of 461 consecutive resections were evenly distributed among three surgeons (141, 155, and 165). Median operating time was 180 minutes for Cases 1 to 30 in each surgeon's experience and declined to a steady state (150-167.5 minutes) for Cases 31 and higher. Subsequently, Cases 1 to 30 were considered "early experience," whereas Cases 31 and higher were combined as "late experience" for statistical analysis. There were no significant differences between patients undergoing resections in the early experience and those undergoing resections in the late experience with respect to age, weight, or proportion of patients with malignancy, diverticulitis, or inflammatory bowel disease. There were greater proportions of males (42 vs. 54 percent, $P = 0.046$) and rectal resections performed (14 vs. 32 percent, $P = 0.002$) in the late experience. Trends toward declining rates of intraoperative complications (9 vs. 7 percent, $P = 0.70$) and conversion to open surgery (13.5 vs. 9.7 percent, $P = 0.39$) were observed with experience. Median operating time (180 vs. 160 minutes, $P < 0.001$) and overall length of postoperative hospital stay (6.5 vs. 5 days, $P < 0.001$) declined significantly with experience. There was no difference in the rate of postoperative complications between early and late experience (30 vs. 32 percent, $P = 0.827$). In conclusion,The learning curve for performing colorectal resections was approximately 30 procedures in this study, based on a decline in operating time, intraoperative complications, and conversion rate. Learning was also extended to clinical care because it was appreciated that patients could be discharged to their homes more quickly(73).

Levels of Gynaecological Laparoscopic Surgery (HKCOG)

Level 1 Basic Procedures

1. Diagnostic laparoscopy
2. Laparoscopic tubal occlusion

Level 2 Minor Procedures

1. Salpingectomy for tubal pregnancy
2. Simple adhesiolysis
3. Salpingectomy for hydrosalpinx with mild pelvic adhesions
4. Ablation of minor stage endometriosis (AFS Stage I-II disease)
5. Myolysis
6. Ovarian drilling
7. Aspiration / fenestration of cyst

Level 3 Intermediate Procedures

1. Oophorectomy or cystectomy for ovarian cysts of 8 cm or less
2. Resection of moderate endometriosis (AFS Stage III disease)
3. Salpingostomy / Salpingotomy
4. Myomectomy for pedunculated fibroid or non-pedunculated fibroid of 3 cm or less
5. Hysterectomy for prolapse

Level 4 Major Procedures

1. Hysterectomy
2. Myomectomy for non-pedunculated fibroid greater than 3 cm
3. Excision of ovarian tumours greater than 8 cm
4. Resection of severe endometriosis (AFS Stage IV disease)
5. Adhesiolysis for severe pelvic adhesions, enterolysis and ureteric dissection
6. Management of pelvic abscess
7. Retropubic bladder neck suspension

Level 5 Advanced Procedures

1. Lymphadenectomy
2. Radical hysterectomy for malignant conditions
3. Pelvic floor support other than colposuspension
4. Presacral neurectomy(70)

Laparoscopic Garry and Reich classification

Type 1: Laparoscopic Diagnosis + Vaginal Hysterectomy
Type 2: Vaginal cuff suspension with laparoscopy + vaginal hysterectomy
Type 3: laparoscopy assisted vaginal hysterectomy (LAVH)
Type 4: Laparoscopic hysterectomy (LH) (laparoscopic uterine artery ligation)
Type 5: Total laparoscopic hysterectomy(TLH)
Type 6: Laparoscopic supracervical hysterectomy(LSH)
Type 7: Laparoscopic hysterectomy and lymphadenectomy(LHL)
Type 8: Laparoscopic hysterectomy and lymphadectomy with omentectomy(LHL + O)
Type 9: Radical Laparoscopic hysterectomy(RLH) (58)

In this study, we will compare hysterectomy in learning curve (including about 50 first surgeries) with open hysterectomy of the same surgeon,expert in open surgery, for complications, hospital stay duration, transfusion, operative time, and re-admission.

MATERIALS AND METHODS

Study area and study population: In a prospective cohort study, patients undergoing hysterectomy at Imam Hossein Medical center (academic Medical center located in the Tehran province) were randomly assigned into laparoscopic and Laparotomy groups from 2016-18.

In this study, surgeon was the same in all operations. It should be noted that the suegeon's work experience in open surgery was about 20 years, and she was expert and radical gyneco-oncologist and referal of difficult surgical procedures. The above mentioned surgeon began to perform laparoscopy in hysterectomy by participating in 3 laparoscopic workshops and using Trainer for a period of 6 months and clinical practice with expert laparoscopist for 6 months mostly in level 3 operations, finally participated in one month compact laparoscopy course again and started laparoscopic hysterectomy operations(level 4), independently.

From the beginning, under study information of cases were recorded regarding complications, hospital stay, operative time and blood transfusion.

Surgical techniques

The patient was placed in the lithotomy position with her legs open at 60°, under general anaesthesia with endotracheal intubation; a Foley urinary catheter ensured the bladder was emptied during the operation.

After a CO_2 pneumoperitoneum was created, a 10 mm trocar was placed in the umbilical site by modified hassen technique to introduce the laparoscope and the camera. Three ancillary 5 mm trocars were also placed two in left side (7 cm apart to each other) and one in right side of the patient. The surgeon operated ipsilateraly and her assistant worked in contra lateral side and handled the camera at the same time.

After an accurate abdominal pelvic inspection, lysis of any adhe- sions was performed. The uterus was then mobilized, making the various anatomical planes more accessible. Particular attention was given to the course of the ureter in its pelvic zone. The round ligament was sectioned at ~3 cm from the uterus, by harmonic Ace in order to prevent bleeding from the superior uterine vessels. The areolar tissue of the broad ligament was then dissected and its posterior fold fenestrated at an avascular area above the uterine vessels. This manoeuvre permitted a better mobilization and identification of the infundibulo-pelvic ligament, whose vessels were cut using harmonic Ace under direct visualization of the pelvic ureter.

Once the uterine ligaments were sectioned, the operation continued centrally in a downward direction. If, however, the adnexae were not to be removed, the utero-ovarian ligament was sectioned proximal to the ovaries.

Thereafter, the vesico–uterine peritoneal fold was opened and a bladder dissection from the low uterine segment down to the upper part of the vagina was performed; during this step, the location of the right cleavage plane was crucial to avoid any bladder injury. At this point, the uterine artery was carefully skeletonized and, by exerting the right pressure on the uterine manipulator, it became more evident at the level of the ascendant branches and was then ligated by sutures. This step was critical because most ureteral injuries during laparoscopic hysterectomy are known to occur at this time during surgery.

Circular monopolar colpotomy was then performed and the uterus was removed through the vagina, and sent for histological examination.
At this stage, the uterine manipulator was extremely effective in completely exposing the fornices and at the same time in avoiding CO2 leakage from the pneumoperitoneum, thus making colpotomy easier. Finally, the vaginal vault was sutured continuosly laparoscopically, and the pelvis was then checked in order to ensure haemostasis and to perform pelvic irrigation, thus removing blood clots. At the end of the surgery, only fascia site of 10 mm trochars was repaired.
Abdominal hysterectomy and minor ovarian-tubular surgery were performed according to the technique described for benign disease by Pfansteal incision. In open surgery hemostasis was performed by electrocautery and suturing and in the case of hysterectomy, vaginal cuff was closed.
The beginning of the operation was calculated as the moment of the umbilical incision and for laparoscopic hysterectomy and as the moment of cutaneous incision for the abdominal technique. Cutaneous suture was considered the end of the operation in both cases.

Sample Size: Cases of hysterectomy divided into 54 laparoscopy and 57 laparotomy method. Laparoscopy cases were considered in learning curve group. So, there were two groups of hysterectomy including laparoscopy (learning) and laparotomy.

Data Collection: Complications during hospital stay and after discharge, blood transfusion, duration of hospitalization, re-admision, and surgical time of patients were compared between two groups.

statistical method

The normal distribution of quantitative data was performed using Shapiro-Wilk test. Quantitative data were displayed using mean, standard deviations, mid-range and inter-quartile domains. the qualitative data was displayed using frequency and percent. Data were analyzed by ANOVA, Kruskal-Wallis, T-independent, Mann-Whitney and Kendall-Tau coefficients for comparing quantitative responses between groups. Guerrilla post hoc test was used whenever necessary. Chi-square test was used to compare the qualitative responses between the studied groups and, if necessary, exact P value was calculated. Covariance analysis was used to compare post operative hemoglobin between the studied groups. The significance level for statistical tests was considered 0.05. SPSS software version 25 was used for data analysis.

RESULTS

Results:

A total of 111 patients underwent hysterectomy.

In the hysterectomy group, 111 patients, including laparoscopy in learning curve group (54) and laparotomy (57) were studied.

Medical disease, mean age and pre-operative hemoglobin level were not significantly different in patients under 2 groups of laparotomy and laparoscopy (Table 1)

Table 1: Comparison of demographic data, underlying medical disease and pre-operative hemoglobin level in laparoscopic and laparotomy groups of hysterectomy surgery.

group	Mean age (SD)	P	Medical disease N (%)	P	Mean BMI (SD)	P	Mean pre-operative Hb (SD)	p
laparoscopy	46.37 (6.8)	0.318	35/54 (64.8)	0.657	28.18 (4.7)	0.712	11.57 (1.76)	0.516
laparotomy	47.7 (7)		34/56 (60.7)		28.59 (5.7)		11.34 (1.94)	

There was no significant difference regarding intra and post-operative transfusion in laparoscopy and laparotomy groups of hysterectomy. (Table 2)

Table 2: Comparison of intra and post-operative transfusion in laparoscopy and laparotomy of hysterectomy surgery

group	Intra-operative transfusion N(%)	P	Post-operative transfusion N(%)	P
Laparoscopy	3/54 (5.6)	0.999	8/54 (14.9)	0.225
laparotomy	5/57 (8.9)		5/57 (8.8)	

Operative time was significantly different in laparoscopy and laparotomy subgroups of hysterectomy, longer in the laparoscopic group. (Table 3)

Table 3: Comparison of operative time in laparoscopic and laparotomy groups of hysterectomy.

group	Mean operative time (SD)	P
Laparoscopy	277.44 (84.48)	0.005
laparotomy	196.75 (62.13)	

There was no significant difference of hospital stay duration in laparoscopy and laparotomy groups of hysterectomy (Table4).

Table4: Comparison of the hospital stay duration of laparoscopic and laparotomy groups in hysterectomy surgery

group	Mean hospital stay (SD)	P
Laparoscopy	2.59 (1.22)	0.211
laparotomy	2.7 (1.08)	

there were no significant differences between the two groups of laparoscopy and laparotomy groups of hysterectomy in the post operative complications (during hospital stay and long term) (Table5).

Table5 : Post operative complications in two laparoscopic and laparotomy groups of hysterectomy

complications	Laparoscopy N(%)	Laparotomy N(%)	P
Hospital stay	10/54 (18.5)	4/57 (7)	0.68
Long term	12/54 (22.2)	7/57 (12.3)	0.51
*Total post operative	17/54 (31.5)	9/57 (15.8)	0.51

*some patients had complications both in hospital stay and long term period.

The type of complications during hospital stay, long term and total complications were not significantly different in laparoscopy and laparotomy groups of hysterectomy (p = 0.5). no major complication happened in each of two groups.

There was no significant difference in re-admision of laparoscopy and laparotomy groups of hysterectomy. (Table6)

Table 6: Comparison of re-admision in laparoscopic and laparotomy groups of hysterectomy.

group	Re-hospitalization N(%)	P
Laparoscopy	1/54 (1.9)	0.999
laparotomy	1/57 (1.8)	

No case of conversion to laparotomy existed in studied laparoscopy cases.

Summary of main results

Transfusion during and after surgery did not differ significantly between the laparoscopy and laparotomy groups.

The surgical time of the two groups had significant difference (277 minutes in laparoscopy versus 196 minutes in laparotomy)

Complications during hospitalization, long term (after discharge) and total complications of surgery were not significantly different between the two groups of laparoscopy and laparotomy.

Hospital stay was not different in two groups of laparoscopy and laparotomy (2 days in each group).

Re-admision was not different in two groups.

There was no case of conversion to open surgery in laparoscopy patients.

DISCUSSION

transfusion and blood loss

In the present study, transfusion during and after surgery did not differ significantly between the laparoscopy and laparotomy groups.

In a study laparoscopic and open hysterectomy were compared, and learning curve was investigated in a prospective study(47). Postoperative complications in the laparoscopic hysterectomy group were fever after surgery in one patient and a uretero-vaginal fistula diagnosed 10 days after surgery in one patient, for which it was necessary to introduce a ureteral splint.In one of the first case series of 100 LAVH , it was reported that a depressing 20% complications occurred, including 13 cases with haematoma of the vaginal cuff, two cases of ureteral damage and one case of lesion of the epigastric artery. The good postoperative recovery in 80% of the patients with no intra-operative complications was encouraging (156).

A recently published random study comparing LAVH and abdominal hysterectomy demonstrated that blood loss and postoperative pain were significantly less in the patients who underwent LAVH. Furthermore, the percentage of complications in the two groups was acceptably low and there was no statistically significant difference between the two groups (157).

In the other hand, in the present study just outcome of blood transfusion was compared in 2 groups and volume of blood loss was not measured. Probably if it was done,difference of blood loss volume , might be diffrent in 2 methods. In addition to the experience of the surgeon, the staffing issues and the surgeon's assistant also play a role in outcome of laparascopy including blood loss.

operation time

In the present study,the surgical time of the two groups had significant difference (277 minutes in laparoscopy versus 196 minutes in laparotomy)

In above mentioned studies laparoscopic and open hysterectomy were compared, and learning curve was investigated in a prospective study and there was no diffrence in complications (47,156-157).
In the study of comparison between Laparoscopic and Open Hysterectomy,The average time employed for laparoscopic hysterectomy was 104.1 ± 26.98 min; according to the learning curve experienced in this study, the range was 72–163 min and the results after the plateau was reached showed no statistical difference between laparoscopic and abdominal operating times(47).

Subsequently, in a randomized prospective trial on 143 patients comparing laparoscopically assisted vaginal hysterectomy (LAVH) and abdominal hysterectomy, it was found that LAVH took significantly longer than abdominal hysterectomy, but duration of hospitalization and convalescence were shorter. This study demonstrated that the level of postoperative complications in the two groups was similar, although one LAVH patient had a vesico–vaginal fistula(52).

According to one report, the difference in duration of surgery for the two techniques is due to the fact that most of these studies were carried out ‘during the world learning curve for laparoscopic hysterectomy’(156).

A recently published random study, comparing LAVH and abdominal hysterectomy demonstrated that surgery for LAVH can take the same time as for abdominal hysterectomy. This study has unequivocally established the importance of the experience of surgeons in the length of time required to perform LAVH(157).
The current study reports the first series of 51 laparoscopic hysterectomies performed in a university centre with significant experience in endoscopic gynaecological surgery. In order to assess the laparoscopic hysterectomy learning curve, the following parameters were examined: duration of surgery, percentage of intra- and postoperative complications and percentage of conversions to abdominal hysterectomy.
In a study, 100 successive laparoscopic hysterectomies performed by a senior gynaecologist were assessed in order to evaluate the learning curve. It was found that the duration of surgery decreased from an average of 180 min for the first 10 operations, to an average of 75 min for the last 20. This study also found a direct correlation between duration of surgery, patient weight and the weight of the uterus. On the contrary, no relationship of this kind was found in our study(158).
Interestingly,in a study noted that in eight patients who had previously undergone hysterectomies (Caesarean section or myomectomy), the duration of laparoscopic surgery decreased over the period of this study when compared to the operating times of the other cases, thus confirming the importance of the learning curve(47).

In the medical center of the present study, the nursing staff, equipment, and engineering were also in training period (learning curve), and the effect of these factors was also evident in operative time. For instance, unchecked instruments, camera, and monitoring system exhibited problems during operation which take time to solve each of them. Of course whenever the working system develops, less problems occur during operation and if happens, solution is rapidly done.

Complications

In the present study, Complications during hospitalization, long term (after discharge) and total complications of surgery were not significantly different between the two groups of laparoscopy and laparotomy.

No serious complications occurred in two groups, and re-admission of the two groups did not differ.

Considering that the surgeon was expert in the open surgery and radical operations, the complications of her open surgery was less. The point that complications of the open surgery group with a 20-year experience of surgeon and laparoscopic surgery in her learning curve did not have a significant difference, is in favor of confirming less complications of laparoscopic surgery.

Hospital stay

In a study of laparoscopic and open hysterectomy, The mean length of hospital stay was 2.38 ± 0.30 days in the laparoscopic hysterectomy group versus 6.23 ± 1.85 days in the abdominal hysterectomy group (P ≤ 0.001)(47).

In the present study, hospital stay was not different in two groups of laparoscopy and laparotomy . However, patients were not discharged, even if they wanted and were ready to leave hospital, given that the surgeon was expert and noted that she was in Learning curve and was willing to close observe post operative period of laparoscopy patients.
In this study, the need for patient pain relief, comfort, satisfaction, and quicker return to work were not considered, which might be better in the laparoscopic group.

re- admition

In the present study,re-admition was not different in two groups.

conversion rate

In laparoscopic colorectal surgery conversion rates was studied. The conversion rate for right-sided colonic resections was 8.1% (n _ 457) compared with 15.3% for left-sided colorectal
resections (n _ 443). Independent predictors of conversion of laparoscopic to open surgery were the body mass index (BMI) (odds ratio _OR_ _ 1.07 per unit increase), ASA grade (OR _ 1.63 per unit increase), type of resection (left colorectal versus right colonic procedures, OR _ 1.5), presence of intra-abdominal abscess (OR _5.0) or enteric fistula (OR _ 4.6), and surgeon's experience (OR 0.9 per 10 additional cases performed). Having adjusted for case-mix,the CUSUM analysis demonstrated a learning curve of 55 cases for
right-sided colonic resections versus 62 cases for left-sided resections.Median operative time declined with operative experience (P _ 0.001). Readmission rates and postoperative complications remained unchanged throughout the series and were not dependent
on operative experience.In conclusions, Conversion rates for laparoscopic colectomy are dependent on a multitude of factors that require appropriate adjustment including the learning curve (operative experience) for individual surgeons. The laparoscopic model described can be used as the basis for performance monitoring between or within institutions. However, this study did not demonstrate a reduction in the readmission rate and complication rate with increasing experience despite a significant reduction in the operating time and conversion rate. The possible explanation for this paradox is the significant shift toward more complex and highrisk cases in the later part of the series, thus resulting in an overall stable complication and readmission rate. Similar findings were reported by Marusch et al21 in a multicenter study of 1658 patients, which showed that surgeons with experience of more than 100 laparoscopic colorectal operations were more

likely to embark on more difficult cases with a conversion rate of 4.3% versus 6.9% for surgeons with experience of less than 100 procedures yet identical postoperative mortality and morbidity between the 2 groups (150).
The main reason for the conversion rate is usually a complication. So,conversion and complication rate are more in learning curve.in the present study, There was no case of conversion to open surgery in laparoscopy patients.

learning curve

Transfusion

In the present study,transfusion during and after surgery did not differ significantly between the laparoscopy and laparotomy groups.

A study in laparoscopic and laparotomy hysterectomy showed that bleeding during laparoscopic surgery was less than open surgery. ($p < 0.001$).Average intra-operative blood loss was lower in laparoscopic hysterectomy than in abdominal hysterectomy ($P \leq 0.001$).

Blood loss during laparoscopic hysterectomy was calculated as the difference between the volume of liquid introduced into the pelvic cavity for irrigation purposes and the volume of liquid aspirated during the operation. Blood loss during abdominal hysterectomy was assessed by measuring the amount of blood contained in the aspirator at the end of the operation: sponges were not used for this study.
The following parameters were also evaluated: postoperative decrease in haemoglobin (Hb), complications and duration of post- operative stay.
Average intra-operative blood loss was significantly lower in laparoscopic hysterectomy as opposed to abdominal hysterectomy, with lower first postoperative day haemoglobin drop in the patients who underwent laparoscopic hysterectomy.
In comparison of total laparoscopic hysterectomy versus abdominal hysterectomy,there were no intra-operative complications in the abdominal hysterectomy group, but the postoperative complications were: two cases of haematoma of the vaginal cuff (blood transfusion was required in one case), and four cases of postoperative fever.
There were no intra-operative complications in the abdominal hysterectomy group, but the postoperative complications were: two cases of haematoma of the vaginal cuff (blood transfusion was required in one case), and four cases of postoperative fever(150).
A recently published random study (Marana et al., 1999) comparing LAVH and abdominal hysterectomy demonstrated that blood loss and postoperative pain were significantly less in the patients who underwent LAVH. Furthermore, the percentage of complications in the two groups was acceptably low and there was no statistically significant difference between the two groups. This study has unequivocally established the importance of the experience of surgeons in the length of time required to perform LAVH(47,157).

CONCLUSION

In the present study, hysterectomy patients were operated on in two groups of laparoscopy (learning curve)and open surgery of expert and radical surgeon, which did not differ in terms of complications, transfusion, duration of hospitalization and re-admission.However,surgical time was significantly longer in laparoscopy group.This study encourage starting laparoscopy method instead of open surgery, even in setting of expert open surgeons, and even in advanced(level 4) surgery such as hysterectomy.

In the present study the surgeon was gyneco-oncologist and very familiar to pelvic anatomy and expert in open surgery. Probably, equal complication, transfusion, hospital stay and re-admission of laparoscopic hysterectomy in her learning curve in comparison to her open surgery was due to proponged exprience in radical surgeries and might not be the case of every open surgeon.

Other point is no attention and data gathering regarding patient satisfaction with her operation and work return delay after each method of surgery, laparoscopy and open which are main advantages of laparoscopic surgery.

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