Hysterectomy, which is one of the most common surgeries performed on women, dates back to ancient times. The history of hysterectomy comprises biographies of many humble men and the significant individual efforts that they made to fight the skepticism of the medical communities of their times. Many of the pioneers were ignored. Although there are a number of alternatives to hysterectomy available, it remains one of the most frequently performed gynaecological operations. The introduction of antisepsis, anaesthesia, antibiotics and blood transfusion made hysterectomy a safe procedure. Nowadays, we distinguish three different surgical approaches to hysterectomy: vaginal, abdominal and laparoscopic. The limitations of conventional laparoscopy have led to the development of robotic surgery, which has evolved over the past decade from simple adjustable arms to support cameras in laparoscopic surgery to more sophisticated four-armed machines now being in use worldwide.

Keywords: hysterectomy; history; laparoscopic surgery; robotic surgery

HysterecToMy: PaST anD PreSENt

Hysterectomy, which is one of the most common surgical procedures performed on women, is mainly associated with noncancerous conditions. Although a number of alternatives to hysterectomy that are now available are increasingly being employed, it remains one of the most frequently performed gynaecological operations.

Vaginal Hysterectomy

Vaginal hysterectomy dates back to the ancient times. There is reference that vaginal hysterectomy was performed by Themison of Athens in 50 BC. It is known that the procedure was performed by Soranus in Greece, 120 years AD, by removing an inverted uterus that had become gangrenous. In the writings of the 11th century, the Arabic physician Alsaharavius stated that if the uterus had prolapsed externally and could not be reinserted, it should be surgically excised. These hysterectomies were carried out sporadically and only for the reason of uterine prolapse or uterine inversion. However, the bladder and the ureter were often torn and the patients rarely survived.

The first authenticated vaginal hysterectomy was performed by the Italian anatomist Berengario da Carpi of Bologna in 1507. The operation was also performed by Andreas da Crusce, in 1560, and Valkaner of Nuremberg, in 1675, with questionable outcome.

One of the first successful vaginal hysterectomies was self-performed in the early 17th century. A 46-year-old peasant named Faith Haworth was carrying a heavy load when her uterus prolapsed completely. Frustrated by this frequent occurrence, she grabbed her uterus, pulled as hard as possible, and cut the whole lot of it with a short knife. The bleeding soon stopped and she lived on for many years, with a persistent vesico-vaginal fistula. This case was well documented and reported in 1670 by a male midwife Percival Willoughby.

The reported mortality rate in the 18th century was 90%, and most doctors were of the opinion that one was unlikely to survive a hysterectomy. Baudelocque of France introduced the technique of artificially prolapsing...
and cutting away of the uterus, in favourable cases. He performed 23 vaginal hysterectomies over 16 years since 1800.

Conrad Lagenbeck of Gottingen performed the first planned vaginal hysterectomy in 1813. He reported the operation in 1817 and was subjected to the jibes of his colleagues for many years, without receiving credit for his achievement. His patient made an uneventful recovery. The removed uterus was lost, and the assistant died shortly after the surgery, so none of his colleagues believed in the report of the operation. The post-mortem examination of the patient, who died of senility 26 years later, showed that the operation had been performed and that the uterus had indeed been removed in its entirety.

The first planned vaginal hysterectomy without prolapse and with entry into the peritoneal cavity was done for cervical cancer in 1822 by Sauter of Baden. The patient survived the operation, but developed the vesico-vaginal fistula and died six months later. The first successful vaginal hysterectomy for cervical cancer was performed in 1829 by the Parisian surgeon Joseph Récamier. He performed the procedure with deliberate ligature of the uterine arteries and broad ligaments. The operation lasted 20 minutes and the patient died later due to spread of the cervical cancer.

The perioperative mortality rate associated with vaginal hysterectomy for cancer was extremely high, such that by 1830, only 3 out of 15 authentic cases survived the operation. At the end of the 19th and the beginning of the 20th century, the development of instrumentation, anaesthesia and antisepsis reduced the mortality rate from 15% in 1886 to 2.5% in 1910. These figures were at that time much lower than the figures relating to abdominal hysterectomy. By the 1920s, the operative mortality rates of both vaginal and abdominal hysterectomy were comparable at 2-3%. One of the strongest proponents of vaginal hysterectomy was Noble Sproat Heaney of Chicago. In 1934 he reported a series of 627 vaginal hysterectomies performed for benign pelvic disease, resulting in death in only three cases. In the first part of 20th century, before the development of gynaecology as separate specialty, many hysterectomies were done by general surgeons who, as not being familiar with vaginal surgery, favoured the abdominal route.

The development of laparoscopical-assisted hysterectomy in the 1990s has led to the reemergence of standard vaginal hysterectomy as the method of choice for most cases of benign gynaecological disease requiring hysterectomy. The first vaginal hysterectomy with laparoscopic assistance was described in 1984. The true role of laparoscopy in facilitating vaginal hysterectomy was to convert cases that could otherwise only have been done abdominally, to a laparoscopically assisted vaginal hysterectomy. Laparoscopic assistance during vaginal hysterectomy not only provides visualisation of the real anatomic picture in the abdominal cavity, but allows the surgeon to perform correction of the associated pathology and some steps of the hysterectomy itself, thus reducing the operating risk of this, to a certain degree, "blind" intervention.

Abdominal Hysterectomy

The pathway to abdominal hysterectomy was laid down with the first laparotomy in the 19th century. The human abdomen was deliberately surgically opened for the first time by Ephraim McDowell, a surgeon of Danville in Kentucky, who successfully removed a 10.2 kg ovarian tumor without anaesthesia, from Jane Todd Crawford, in 1809. A 46-year-old mother of five thought to be in the last stages of labour. After a pelvic examination, she was diagnosed a massive ovarian cyst, and offered to be the subject of an experiment. McDowell operated on her on the kitchen table, performing an ovariotomy. The operation lasted only 25 minutes, but was carefully planned. After a rapid recovery, the patient lived for more than 30 years. McDowell did not publish his case immediately, but waited until he had performed two further ovariotomies, both successful, before publishing his work in 1817. The publication included details such as the removal of blood from the peritoneal cavity and bathing of the intestines with warm water. During his lifetime he performed 13 similar procedures.

In 1843, Charles Clay performed the first recorded abdominal hysterectomy in Manchester, England. He was expecting a massive ovarian tumor, and started what he
expected to be another ovariectomy. Following expelling of a large fibroid uterus, Clay performed a subtotal hysterectomy as a result of a huge uterine fibroid and the patient died of a massive haemorrhage in the immediate postoperative period\(^3\). The following year, after opening the abdomen again upon an incorrect diagnosis, he performed a subtotal hysterectomy and bilateral salpingo-oophorectomy. This time the patient survived the operation, and lived for 15 days, dying after being dropped on the floor while the nurses were changing the bed-clothes\(^1\). The first planned subtotal hysterectomy for uterine fibroids was performed by John Bellinger of Charleston, in 1846. The patient died of sepsis on the 5th postoperative day\(^1\).

Walter Burnham performed the first successful abdominal hysterectomy in 1853, in Lowell, Massachusetts, by accident. Upon opening the patient from the sternum to the pubis, to remove a large ovarian cyst, she vomited, and extruded a large fibroid uterus. As he was unable to put it back into the peritoneal cavity, he proceeded with a subtotal hysterectomy, tying both of the uterine arteries\(^3\). Twelve out of 15 subsequent patients died, however, not survive, dying of peritonitis, haemorrhage or exhaustion\(^5\).

These early hysterectomies were all subtotal procedures, performed usually without anaesthesia, and with the mortality rate of 70-90%, even as late as 1880\(^7\). Abdominal hysterectomy was formally condemned by the Academy of Medicine in Paris in 1872, due to high mortality rate\(^5\). With the development of anaesthesia, antisepsis and surgical instruments, the situation had slowly improved by the end of the 19th century.

In 1929, Richardson in the United States performed the first total abdominal hysterectomy. He recommended the excision of the cervix, to avoid cervical stump carcinoma \(^3\). Despite Richardson’s recommendation, subtotal hysterectomy remained the preferred surgical technique until the late 1940’s. Supracervical hysterectomies were preferred for the prevention of peritoneal contamination with vaginal bacterial flora and for the prevention of peritonitis, with reduced risk of bladder and ureter injury\(^2\).

The advent of antibiotics, blood transfusion, modern anaesthesia and improved surgical techniques in the 1940’s, and the recognition that cancer occasionally developed in the cervical stump, encouraged and emboldened surgeons to carry out total hysterectomy. During the subsequent two decades when various antibiotics became available and infectious morbidity had decreased, total abdominal hysterectomy became the standard of care. Total hysterectomy supplanted supracervical techniques, largely as a method for preventing carcinoma of the cervix\(^1\). Apart from the transition from subtotal to total hysterectomy during the 20th century, the only change in the abdominal procedure was the almost universal adoption of the transverse incision introduced by Johannes Pfannenstiel, in 1900, which gives better cosmetic result with fewer surgical complications\(^7\). The increased safety of hysterectomy led to an explosive increase in the number of procedures performed, so that it is now the second most common operation performed on women, after caesarean section\(^1\).

**Radical Hysterectomy**

Radical hysterectomy was initially developed as a surgical treatment for cervical cancer due to the absence of other modalities of treatment. John Clark performed the first radical hysterectomy at Johns Hopkins Hospital, in 1895\(^\text{1,8}\). Clark and Ries noted the spread of cancer to the tissues and lymph nodes beyond the limits of excision of the standard hysterectomy. Each of them developed a more radical hysterectomy, removing more of the broad ligament, vagina and the associated pelvic lymph nodes\(^1\).
In 1898, Ernst Wertheim, a Viennese physician, performed the first full extended radical operation for cervical cancer. He developed radical total abdominal hysterectomy with removal of the uterus, tissues surrounding the upper vagina, pelvic lymph nodes and the parametrium. Wertheim did not routinely perform lymphadenectomy, removing only clinically enlarged or suspicious nodes. When he reported the outcomes of the treatment of the first 500 patients, the mortality rate figure was at 19%. The more radical extension of vaginal hysterectomy was developed by Karl Schuchardt of Göttingen and particularly Friedrich Schauta of Vienna. In 1901, Schauta described radical vaginal hysterectomy and reported a lower operative mortality rate than the one of the abdominal approach. The inability to perform adequate pelvic lymphadenectomy in the vaginal procedure resulted in the sway of the abdominal approach. As a result of the overall, still high mortality rates, radiation therapy replaced surgery as the treatment of choice for cervical cancers. In 1944, Meigs repopularised the surgical approach when he developed a modified Wertheim operation with removal of all pelvic nodes. He reported data on 100 women who all survived radical abdominal procedure. As Meigs routinely performed lymphadenectomy, this became integral to the procedure. There have been several modifications of the operative technique, and in recent years laparoscopy has increasingly been employed in the management of early-stage cervical cancer.

The introduction of organised screening programs has resulted in decreased mortality rates and incidence of cervical cancer and a noticeable stage shift from more advanced to earlier stage disease. The advent of early detection of preinvasive cervical neoplasia has led to reevaluation of the need for total hysterectomy in many patients, and implementation of more conservative procedures.

The trend towards more conservative surgery is most relevant to younger women diagnosed with cervical cancer. Small invasive cancer has become a more frequently encountered clinical problem and is often diagnosed in women of younger age who wish to retain their childbearing prospects, creating a management dilemma. In 1977, Burghardt and Holzer reported that removal of the uterine fundus and adnexa for the management of small-volume tumors was not necessary. The first conservative surgical approach was proposed by a Romanian gynaecologist, Aburel, and called "subfundic radical hysterectomy". The technique, however, did not become popular.

The first successful systematic conservative surgical approach for invasive cervical carcinoma was described by Daniel Dargent in 1994. He performed the first vaginal radical trachelectomy associated with laparoscopic pelvic lymphadenectomy (LAVRT), in 1986. This operation included a laparoscopic pelvic lymphadenectomy, which was followed by a radical excision of the cervix together with the surrounding parametria and the upper one third of the vagina in order to protect the corpus of the uterus and the ovaries. Cervical cerclage with a non-absorbable suture was performed at the end of the procedure to maintain closure of the uterine isthmus in the event of future pregnancy.

This fertility-preserving surgical treatment for young women affected by early-stage cervical cancer has gained approval of the gynaecologic-oncologic community. Both abdominal and vaginal approaches have been described. Subsequently, Roy and Plante also reported their experiences and successful pregnancies in their series of LAVRT. Worldwide, medical centers have now reported their pregnancy and oncologic results following trachelectomy. After the pioneer of LAVRT passed away in 2005, Querley and Roy suggested the term "Dargent’s operation" to be used for this procedure.

**Laparoscopic Hysterectomy**

The origin of endoscopy can be traced back to the Greek school of Kos led by Hippocrates (460-375 BC), who described the use of rectal and primitive vaginal speculae. The forerunner of the optical system of modern endoscopes was the cystoscope, developed by Nitze of Germany in the 19th century. In 1901, Georg Kelling of Dresden introduced a cystoscope into a dog’s abdominal cavity, thus performing the first laparoscopy. The first human laparoscopy was performed by Hans Christian Jacobaeus of Stockholm in 1911, by using pneumoperitoneum and the Nitze cystoscope.

It was Raoul Palmer of France who popularised gynaecological laparoscopy in the 1940’s and who is considered to be the father of modern gynaecological laparoscopy. The development of rod lens systems, external cold light sources and fiberoptics in the 1950’s improved the visibility, but because of the uncomfortable working position, laparoscopy was used only by a limited group of gynaecologists in the 1970’s (Semm and Mettler in Germany, Bruhat in France, Gomel in Canada, and Hulka and Phillips in the United States). In the 1980s, the introduction of videolaparoscopy and monitors was revolutionary and it became clear that laparoscopy could be used for therapy as well as for diagnosis. Streptoe and Edwards recovered the first oocyte for in vitro fertilisation using the laparoscope.

Kurt Semm in Germany first described a technique for laparoscopic assistance in vaginal hysterectomy, in 1984. The adnexa were separated laparoscopically in order to simplify vaginal hysterectomy. This was later called laparoscopically assisted vaginal hysterectomy. In 1988, Harry Reich performed the first total laparoscopic hysterectomy in Pensylvania. The ligaments and uterine vessels were coagulated with bipolar forceps and cut with scissors. The vagina was opened and closed laparoscopically. The total operating time was 180 minutes, the uterus weighed 230g and the patient was discharged on the fourth postoperative day. Reich published his article the following year and demonstrated his technique worldwide.

Since the first case published by Reich and coworkers, an increasing number of authors have reported their techniques. Nowadays, there are a number of different subtypes of laparoscopic hysterectomy. They are usually de-
fined by the extent of laparoscopic dissection performed during the procedure. This procedure appears to be a real alternative of hysterectomy by laparotomy, worthy of becoming a routine intervention. The generic advantages of avoiding a large laparotomy are now well established. For the patient, a laparoscopic procedure is invariably less painful, and the recovery and return to normal activities are more rapid. There are also significant gains in short-term quality of life measures associated with laparoscopic approach. In addition to the patient-oriented benefits, there are significant benefits for the surgeon. Modern laparoscopes give an unsuppressed view of the pelvic anatomy and pathology, particularly in relatively inaccessible areas of the deep pelvis, anterior cave of Retzius and pelvic sidewalls. Thus, for the surgeon, improved visualisation offers the opportunity of more precise and accurate surgery.

With the advent of laparoscopic hysterectomy, many surgeons, wanting a simpler approach and for a variety of other reasons, returned to the performance of subtotal hysterectomy. In 1993, Semm developed intracervical laparoscopic supracervical hysterectomy with a technique of cutting out the transformation zone and the central core of the uterus. This procedure helps avoid ureter injury and lessens the risk of ascending infection. Others have developed techniques of removing the transformation zone with an electrosurgical loop or coagulating it with the Nd:YAG laser. Thus the possibility of the cervical carcinoma should theoretically be reduced, although all those authors suggest annual cervical surveillance. Subtotal hysterectomy is still the subject of controversy in current practice.

The growing safety of laparoscopic hysterectomy suggests that it will be increasingly used in the future, although development of less invasive alternatives, such as hysteroscopic surgery, endometrial ablation techniques, levonorgestrel-releasing intrauterine device, gonadotropin-releasing hormone analogues, and interventional radiology, may reduce the traditional indications for hysterectomy. The significance of laparoscopic hysterectomy role remains difficult to define, as it will be different for each surgeon or institute, region or country and most importantly, for each pathology. Although there are no absolute contraindications for laparoscopic hysterectomy, the surgeon's experience and the pathology encountered are the limiting factors for performing this procedure.

FUTURE PERSPECTIVES

The most recent development in hysterectomy is the introduction of hysterectomy techniques which make use of surgical robots. The motivation to develop surgical robots is rooted in the desire to overcome the limitations of current laparoscopic technologies, and to expand the benefits of minimally invasive surgery. When compared with conventional laparoscopy, robotically assisted procedures are reported to provide significant improvements in instrument dexterity, eliminating natural hand tremors, camera stability, three-dimensional visualisation and ergonomics. The history of robotics begins with the Puma 560, a robot used in 1985 to perform neurosurgical biopsies with greater precision. The first commercial application of robotics was the use of the Automated Endoscopic System for Optimal Positioning (AESOP), a robotic arm controlled by the surgeon voice commands to manipulate an endoscopic camera, marketed in 1994. Nowadays, robotic systems da Vinci S and da Vinci SI are equipped with a double optic, which gives the operator three-dimensional view of the operative field, and with adjustable magnification, enabling much improved vision of the pelvis. This system was developed in the US as an attempt to allow telesurgery for wounded soldiers, and it consists of three components: the robotic cart with instruments, the vision cart and the surgeon console (Figure 2A, 2B, 2C). The surgeon sits away from the patient at ergonomically designed console which has a stereoscopic viewer, hand manipulators and foot pedals, that allow them to control the camera and robotic instruments within the patient (Figure 2A). The robotic cart has 3 or 4 tele-robotic arms for controlling the camera and surgical instruments (Figure 2B). These instruments have a wrist-like mechanism, allowing the surgeon a full 7 degrees of freedom of motion, similar to the human wrist in conventional open surgery. The first successful surgery using the da Vinci surgical system was performed in Belgium in 1997.

In 2002, Diaz-Arrastia reported the first series of successful robotic laparoscopic hysterectomies. Robotic hysterectomy to treat benign disease became popular after the initial reports by Reynolds and Advincula in 2006, presenting 16 consecutive cases with no conversions to laparotomy, and with complication rate compatible with that of routine laparoscopic surgery. Robot-assisted hysterectomy has been evaluated by several authors, initially in small pilot series and more recently in a retrospective comparison to total laparoscopic hysterectomy. Initial results show that complication rates and short-term outcomes compare favourably to conventional laparoscopic operations. There is evidence suggesting that robot-assisted laparoscopy is a feasible option for surgical management of endometrial and cervical cancer. There are only published case reports or series documenting the experience with ovarian carcinoma. In 2006, Sert published the first report regarding robotic radical hysterectomy. Margina et al. demonstrated that radical hysterectomy performed using robotic techniques was comparable with laparotomy, with equal lymph node harvest, shorter operating time, and reduced blood loss and the length of hospital stay. Sert and Abler published the first comparative study of robotic and laparoscopic cases with no statistical differences in operating time, number of lymph nodes or parametrical widths, and with less blood loss and shorter hospital stays, concluding that robotics is superior approach over traditional laparoscopy. Data on the application of robotic technology for ovarian cancer staging is scant.

Applications of robotic surgery are expanding rapidly. Its disadvantages are the present high cost, lack of tactile feedback, lack of vaginal access, bigger trocar size and more limited options for its placement, bulkiness of the
equipment, additional time required to assemble the robot and the need for training. One exciting possibility is expanding the use of preoperative (computed tomography and magnetic resonance) and intraoperative video image fusion to better guide the surgeon in dissection and in identifying pathology. The nature of the robotic systems enables teleconsulting (long-distance intraoperative consultation or guidance), telementoring (opportunities for teaching and assessing of new surgeons through simulation) and teleanalysing at distance (operating on a patient who is remotely located from a surgeon). In 2001, robotic tele-surgical machines were used to perform the first transcontinental cholecystectomy. The surgeon was in New York and the patient was in Strasbourg.

Although the current evidence demonstrates the feasibility of robotic surgery in gynaecology, more multi-institutional prospective randomised trials evaluating efficacy and safety must be undertaken. If evidence-based long-term outcome evaluations show superiority of robotic surgery in comparison to conventional laparoscopic and open surgery, this technique might have a major impact on gynaecological surgery.

SUMMARY

HISTEREKTOMIJA KROZ ISTORIJU

Histerektomija, koja predstavlja jednu od najčešćih operacija kod žena, datira od davnina. Istorija histerektomije sadrži biografije mnogih skromnih ljudi i njihovih značajnih pojedinačnih napora koje su uložili u borbi protiv skepsa medicinskih udruženja svog vremena. Mnoge pionire ove struke su ignorisali. Iako postoje brojne alternative histerektomiji, ona je i dalje najčešće primjenjivana ginekološka operacija. Uvođenje antisepe, anestezije, antibiotika i transfuzija krvi učinila je histerektomiju bezbednom procedurom. Danas razlikujemo tri različita hirurška pristupa histerektomiji: vaginalni, abdominální i laparoskopski. Ograničenja konvencionalne laparoskoopije dovela su do razvoja robotske hirurgije koja se u poslednjoj deceniji razvila od jednostavnih podesivih nosača kamere u laparoskopskoj hirurgiji do sofisticiranih četvororučnih mašina koje se sada koriste širom sveta.

Ključne reči: histerektomija; istorija; laparoskopska hirurgija;

REFERENCES