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HISTORY OF MEDICINE / ИСТОРИЈА МЕДИЦИНЕ

Hysteroscopy – history and development

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SUMMARY
Hysteroscopy is the gold standard for diagnosing and managing endocervical and endometrial pathology. The development of today's hysteroscopy begins in the early 19th century. Initially, hysteroscopy was used solely for diagnostics. Operative hysteroscopy surfaced with the development of distension media, the hysteroscope, and its associated instruments. Operative hysteroscopy underwent the most significant development in the early 1970s, when new hysteroscopes were introduced, and the distension media became more widely used. A multitude of hysteroscopic procedures are performed with the common goal of removing pathological changes in the endometrial cavity.
In the 1980s, small cameras, also known as "chip" cameras, were developed, leading to the transition of endoscopy into videoendoscopy. Bettocchi revolutionized modern hysteroscopy in 1996 when he used the first operative office hysteroscope. Operative resectoscopes, containing monopolar and bipolar energy, were also constructed. Hysteroscopic morcellators have been in use since the beginning of the 21st century. Today's modern hysteroscopy represents a safe diagnostic and operative endoscopy.
Keywords: hysteroscope; resectoscope; morcellator; operative hysteroscopy

INTRODUCTION

Hysteroscopy is an endoscopic procedure, which can diagnose and treat the pathology of the endometrium, tubal ostia, and cervical canal. Hysteroscopy can be diagnostic and/or operative. The name "hysteroscopy" originates from Greek words *ύστέρα* – uterus and *σκοπέω* – to look. Hysteroscopy is the oldest endoscopic method in gynecologic surgery. The theoretical concept of hysteroscopy dates back to BC Babylon of Mesopotamia. An instrument, similar to today's speculum, was discovered on Babylonian plaques, which was used to determine whether bleeding was of uterine or vaginal origin [1, 2].

Modern hysteroscopy has been developing since the beginning of the 19th century. New optic hysteroscopes were built, and carbon dioxide was used as a distention medium for the uterine cavity. In the 1960s, hysteroscopes were constructed with a one-way canal for irrigation. At the beginning of the 1970s, operative hysteroscopy started developing. The construction of a two-way distention medium delivery system, modern instruments, monopolar and bipolar energy generators, hysteroscopic pumps, resectoscopes and fluid distention media contributed to the development of modern hysteroscopy in the 1980s. The development of an endocamera enabled the use of video hysteroscopy. Operative office hysteroscopes were developed at the end of the 20th century. Hysteroscopic morcellators were developed at the beginning of the 21st century. These instruments shorten the operative time and decrease risk of complications. The ongoing technological advancement enables innovation of instruments and equipment, which advance operative technique leading to diagnosis and management of pathological intrauterine changes [3, 4].

THE DEVELOPMENT OF HYSTEROSCOPY IN THE 19TH CENTURY

Modern hysteroscopy originates from Philip Bozzini's articles in 1807 where he described the endometrial cavity, the existence of intrauterine tumours and malformations. He used a candle and a concave mirror as an illumination method (Figure 1). In 1853, Desormeaux developed the first cystoscope, and it was used to perform the first cystoscopy [2]. The cystoscope had two channels, one for introduction of liquids and the other for instruments. He used


Figure 1. Bozzini's Lichtleiter or light conductor

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Figure 2. Desormeaux's endoscope

a lamp and a concave mirror as an illumination method (Figure 2).

The first hysteroscopy on an actual patient was performed in 1869 by Pantaleoni. Pantaleoni used the cystoscope developed by Desormeaux. He discovered that an endometrial polyp was the source of bleeding in a 60-year-old woman, and treated it with silver nitrate. A second generation of cystoscope was constructed in 1879 by Nitze, which contained optic lenses. In 1898, Duplay and Clado published the first book on hysteroscopy [4].

THE DEVELOPMENT OF HYSTEROSCOPY IN THE FIRST HALF OF THE 20TH CENTURY

In 1907, David constructed the first contact hysteroscope, and performed the first optic hysteroscopy. However, the endometrial visualization was not optimal, as contact hysteroscopy did not use a distension medium. In order to improve the visualization of the endometrial cavity, it was necessary to distend the endometrial cavity during optic observation. For this reason, Heinberg constructed an irrigation system in 1914. In 1925, Rubin constructed a hysteroscope and carbon dioxide was used as the distension medium [2]. Seymour constructed a hysteroscope for introduction and suction of the distension medium in 1926. The first hysteroscope with an operative channel was developed by Mikulicz-Radecki and Freund in 1927, which enabled endometrial biopsy by ocular observation. The hysteroscope equipped with an irrigation system was built by Gauss in 1928 [5]. In 1934, Schroeder improved the hysteroscope by placing the lens at the top, which also improved visualization. A liquid with properties similar to water was used as the distension medium. He used the hysteroscope to diagnose endometrial polyps, submucous fibroids and to determine the menstrual cycle phase [2]. In 1936, Second designed the optic hysteroscope with a fluid delivery system and fixed optics. Palmer directly visualized the endocervical canal during hysteroscopy in 1942, and suggested this be the standard of care during all hysteroscopic procedures. Norment placed the light source on the proximal end of the hysteroscope and by doing so, contact hysteroscopes were modified in 1947 [5].

DEVELOPMENT OF HYSTEROSCOPY IN THE SECOND HALF OF THE 20TH CENTURY

The advancement of hysteroscopy during this period was marked by the introduction of new distension media and operative hysteroscopy (i.e. performing operative procedures using the hysteroscope). In 1962, Silander used a hysteroscope with two channels, an internal canal for observation and an external for irrigation. The distal end of the hysteroscope had a lamp and thin balloon. By alternating the pressure in the balloon and maneuvering the hysteroscope, it was possible to examine the endometrial cavity in great detail [2]. A fiberoptic cable was built into the hysteroscope in 1965. The illumination was accomplished using cold xenon light, and the light source was located outside the body.

The development of modern hysteroscopy began in the 1970s. From 1980, hysteroscopy was accepted as the standard procedure to diagnose and treat endometrial cavity and endocervical canal pathology [6]. New hysteroscopic instruments were developed, and the distension media became more widely used. Office hysteroscopy was performed in outpatient setting without the use of an anesthetic. Operative hysteroscopic procedures continued to develop and became more widely utilized [7].

The available types of hysteroscopes included rigid, flexible, and contact. Hysteroscopes are available in different diameters with different observation angles [2]. The most commonly used is the rigid hysteroscope, which consists of a telescope with a diameter of 2.9 mm, a 30° angle, and an outer sheath of 5 mm (Figure 3). The first flexible hysteroscope was constructed by Mohri in 1971. These hysteroscopes are fiberoptic, ranging from 3.1 mm to 3.7 mm, and are used for diagnostics. Semi-rigid fiberoptic mini hysteroscopes Verascope (Gynecare, Ethicon, Somerville, NJ, USA) have a 1.8 mm telescope, 0° angle and an outer sheath of 3.2 mm. These hysteroscopes are used for diagnostic and operative procedures. These hysteroscope can use mechanical instruments, such as scissors, grasper and biopsy forceps, as well as 5Fr bipolar electrodes for resection, coagulation, and vaporization.

Since 1970, the use of new media for the distension of the uterine cavity begins. Edstrom (1970) used 32% dextrose (MW 70 000 Daltons) as the distension medium during biopsy of endometrial lesions. Since then, a few media have been used successfully to distend the endometrial cavity [8]. Lindemann (1971) used carbon dioxide as the distension medium. Menken (1972) used the high-molecular weight solution polyvinylpyrrolidone as the distension medium, while Sugimoto (1975) used isotonic

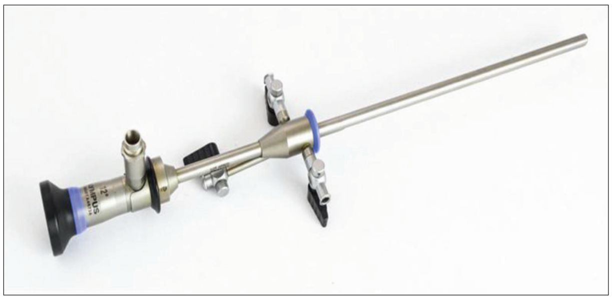

Figure 3. Rigid hysteroscope

Figure 4. Bettocchi office operative hysteroscope

Figure 5. Olympus bipolar resectoscope

sodium chloride and Quinones-Guerrero (1976) used 5% dextrose [9, 10].

Hysteroscopic procedures became possible, and have continuously improved with the use of distension media and development of new instruments. Female sterilization was performed using operative hysteroscopy by Menken in 1971. Lindemann and Quinones-Guerrero successfully performed transcervical catheterization of fallopian tubes using hysteroscopy in 1972. The treatment of intrauterine adhesions using hysteroscopy was first performed by Porto in 1973. In 1974, Edstrom used the biopsy forceps for intrauterine adhesiolysis, as well as to perform metroplasty i.e. resection of uterine septum. In 1976, the first hysteroscopic transcervical resection of a submucous fibroid using an urologic resectoscope, monopolar current and 32% dextran 70 as distension medium was done by Neuwirth and Amin [2, 11]. A resectoscope was used for hysteroscopic myomectomy by Hanning and colleagues in 1980. Hysteroscopic laser endometrial ablation was performed by Goldrath and colleagues in 1981 [12].

The charge-coupled device (CCD), also known as the "chip," was developed in 1982 consisting of a small endocamera and a sensor, which led to the transition from endoscopy to videoendoscopy. The high definition (HD) camera was developed later. De Cherny and colleagues used a resectoscope in 1986 to resect a uterine septum. Hysteroscopic myomectomy using a Nd:YAG laser was performed by Baggish in 1989. Hysteroscopic resection of a uterine septum with a Nd:YAG laser was performed by Choe in 1992. Fedele and colleagues used an argon laser to resect a uterine septum in 1993 [13, 14].

In 1996, Bettocchi developed the first "office" operative hysteroscope, which was used for outpatient procedures. It consisted of a telescope of 2.9 mm diameter, covered with a continuous flow sheath and an operating sheath equipped with a channel for semi-rigid 5Fr surgical instruments and electrodes (Figure 4). The hysteroscope can be inserted into the uterus without cervical dilatation, and it enables the operative procedure to be performed in outpatient settings. The Bettocchi office hysteroscope with telescope of 2 mm diameter, simple flow, and outer 3.6 mm sheath is used for diagnostic hysteroscopy. There is the option of using the Bettocci Integrated Office Hysteroscope (B.I.O.H.) diameter 4mm, for diagnostic and office-based procedures [15, 16, 17].

Further development of technology led to the construction of the operative resectoscope, which uses monopolar energy. The resectoscope is used for operative procedures, and consists of a telescope ranging 2–4 mm, 12º angle, two sheaths with irrigation and suction channels, and an operative part that bears the cut/coagulation electrodes. The resectoscope is connected to a high frequency electrosurgical unit. When using high frequency monopolar energy for operative hysteroscopy, the distension medium must be without electrolytes (i.e. 4% sorbitol-mannitol, 1.5% glycine, 5% glucose). After that, a bipolar resectoscopes have been constructed by several manufacturers, including Karl Storz (Tuttlingen, Germany) with 22 and 26Fr diameters, as well as Olympus Corporation (Tokyo, Japan) bipolar resectoscope has an 8.5 mm outer sheath, with a 12º telescope (Figure 5) and Richard Wolf Medical Instruments Corporation (Vernon Hill, IL, USA) princess resectoscope with 21Fr diameter. Bipolar resectoscopes enable transcervical submucous fibroid resection, uterine septum resection, endometrial polyp removal, endometrial biopsy and ablation, and intrauterine adhesiolysis [18, 19]. Utilization of this resectoscope enables the use of distension media that have a low viscosity and contain electrolytes, such as 0.9% sodium chloride and Ringer's lactate, which reduces the risk of hyponatremia and transurethral resection of the prostate syndrome during the surgical procedure [20].

The advancement of monopolar and bipolar electrosurgical technology enabled the introduction and utilization of multipurpose electrosurgical systems. This includes the Gynecare Versapoint bipolar electrosurgery system, which has been in use since 1997. This system contains high-frequency electrosurgical generator and a bipolar resectoscope. Modern high-frequency electrosurgical unit Autocon 400 (Karl Storz) can be operated both in unipolar and bipolar mode [21]. An intelligent electrosurgical unit was also constructed, the Olympus UES-40 SurgMaster

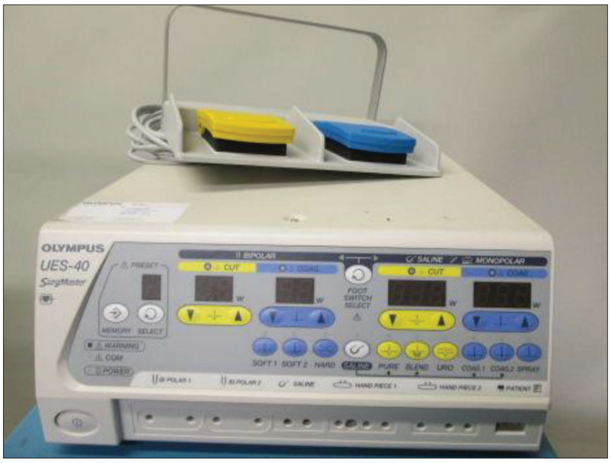

Figure 6. Olympus UES-40 SurgMaster electrosurgical unit


Figure 7. TRUCLEAR hysteroscopic morcellator

generator, as a source of monopolar and bipolar energy, which enables the utilization of the bipolar resectoscope in normal saline (Figure 6).

THE DEVELOPMENT OF HYSTEROSCOPY AT THE BEGINNING OF THE 21ST CENTURY

The beginning of the 21st century is marked by increasing advancement and usage of operative hysteroscopy. With the usage of bipolar energy, laser energy and various instruments, hysteroscopy is a safe method to perform numerous surgical procedures due to the low incidence of complications [22, 23]. Intrauterine morcellation is a newer approach to operative hysteroscopy that removes uterine pathology under direct visualization with continuous real-time tissue fragment removal. Hysteroscopic morcellators were constructed to decrease the operative time and increase the procedural safety. In 2005, the American Food and Drug Administration (FDA), approved the use of the first hysteroscopic morcellator "TRUCLEAR" (Smith and Nephew, Andover, MA, USA) (Figure 7). The morcellator is 9 mm in diameter, and has a rotating blade, which enables the removal of fibroid and polyp tissue from the endometrial cavity, which can then be sent for histopathological examination [24, 25]. The FDA also approved the use of "MyoSure tissue removal system" (Hologic, Bedford, MA, USA) in 2009, which is another type of morcellator, measuring 6.25 mm in diameter with a rotating and oscillating blade. This morcellator can be used to remove submucous fibroids, which measure up to 3 cm in diameter. A mechanical hysteroscopic morcellator is also available and includes the "Bigatti shaver" (Karl Storz) [26, 27, 28].

CONCLUSION

Hysteroscopy represents the gold standard for diagnosis and treatment of endocervical and endometrial cavity pathology. It is a modern and safe endoscopic method, which enables numerous surgical procedures, such as endometrial biopsy, endometrial polyp removal, submucous fibroid resection, uterine septum resection, tubal catheterization, and hysteroscopic sterilization.

Conflict of interest: None declared.

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Хистероскопија – историја и развој

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САДРЖАЈ
Хистероскопија представља златни стандард за дијагнозу и третман ендоцервикалне патологије и патологије шупљине материце. Развој данашње хистероскопије почиње почетком XIX века. У почетку се хистероскопија користила у дијагностичке сврхе. Увођењем у употребу медијума за дистензију материчне шупљине и конструкцијом хистероскопа и инструмената почиње да се развија и оперативна хистероскопија. Најзначајнији развој оперативне хистероскопије почиње седамдесетих година XX века. Конструисани су и нови хистероскопи и почиње све шира употреба медијума за дистензију материчне шупљине. Хистероскопским путем се изводе бројне хируршке процедуре у циљу уклањања патолошких промена у шупљини материце. Осамдесетих година XX века конструисане су и мале ендокамере, чип камере, па тако ендоскопија прераста у видеоендоскопију. Револуцију у свету модерне хистероскопије представља 1996. година када је Беточи пројектовао и употребио први оперативни *office* хистероскоп. Конструисани су и оперативни ресектоскопи, који користе монополарну и биполарну струју. Почетком XXI века конструисани су и почињу да се примењују и хистероскопски морселатори. Данашња модерна хистероскопија представља безбедну дијагностичку и оперативну ендоскопску процедуру.

Кључне речи: хистероскоп; ресектоскоп; морселатор; оперативна хистероскопија