



Paper Accepted*

ISSN Online 2406-0895

History of Medicine / Историја медицине

Ivana Rudić-Biljić-Erski^{1†}, Mladenko Vasiljević^{1,2}, Snežana Rakić^{1,2},
Slađana Mihajlović^{1,2}, Olivera Džatić-Smiljković^{1,2}, Aleksandar Biljić-Erski³

Hysteroscopy – history and development

Хистероскопија – историја и развој

¹Narodni Front Clinic of Gynecology and Obstetrics, Belgrade, Serbia

²University of Belgrade, Faculty of Medicine, Belgrade, Serbia

³Takeda GmbH, Belgrade, Serbia

Received: July 20, 2018

Accepted: November 20, 2018

Online First: January 30, 2019

DOI: <https://doi.org/10.2298/SARH180720001R>

* **Accepted papers** are articles in press that have gone through due peer review process and have been accepted for publication by the Editorial Board of the *Serbian Archives of Medicine*. They have not yet been copy edited and/or formatted in the publication house style, and the text may be changed before the final publication.

Although accepted papers do not yet have all the accompanying bibliographic details available, they can already be cited using the year of online publication and the DOI, as follows: the author's last name and initial of the first name, article title, journal title, online first publication month and year, and the DOI; e.g.: Petrović P, Jovanović J. The title of the article. *Srp Arh Celok Lek*. Online First, February 2017.

When the final article is assigned to volumes/issues of the journal, the Article in Press version will be removed and the final version will appear in the associated published volumes/issues of the journal. The date the article was made available online first will be carried over.

† **Correspondence to:**

Ivana RUDIĆ BILJIĆ-ERSKI

Mihaila Avramovica 22, 11000 Belgrade, Serbia

Email: rudic.biljic@gmail.com

Hysteroscopy – history and development

Хистероскопија – историја и развој

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 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 of the 20th century, small cameras, also known as “chip” cameras, were developed, leading to the transition of endoscopy into videoscopy. 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 21st century. Today's modern hysteroscopy represents safe diagnostic and operative endoscopy.

Keywords: hysteroscope; resectoscope; morcellator; operative hysteroscopy

САЖЕТАК

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 медиума 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 медиума за дистензију материчне шупљине. Хистероскопским путем се изводе многобројне хирушке 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 Беттоцхи пројектовао и употребио први оперативни офис 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

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 Babylon of Mesopotamia in the BC era. 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. Hysteroscopes with a one-way canal for irrigation were constructed in the 1960s of the 20th century.

At the beginning of the 1970s, operative hysteroscopy started developing. The construction of 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 videohysteroscopy. Operative office hysteroscopes were developed at the end of 20th century. Hysteroscopic morcellators were developed at the beginning of 21st century; these instruments shorten the operative time and decrease risk of complications. The ongoing technological advancement enable 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 Phillip Bozzinia'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). The first cystoscope was developed in 1853 by Desormeaux, and 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 a lamp and a concave mirror as an illumination method (Figure 2).

The first hysteroscopy on an actual patient was performed in 1869 by Pantoleoni. Pantoleoni when he used the cystoscope developed by the Frenchman 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 godine Duplay and Clado published the first book on hysteroscopy [4].

THE DEVELOPMENT OF HYSTEROSCOPY IN THE FIRST HALF OF 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 distention 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 distention medium [2]. Seymour constructed a hysteroscope for introduction and suction of the distention 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. Contact hysteroscopes were modified by Norment in 1947, who placed the light source on the proximal end of the hysteroscope [5].

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

The advancement of hysteroscopy in this period was marked by 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 manoeuvring 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 a cold xenon light, and the light source was located outside the body.

The development of modern hysteroscopy began in the seventies of the 20th century. 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 anaesthetic. 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 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. Semirigid fiberoptic mini hysteroscopes Verascope (Gynecare, Ethicon) have a 1.8 mm telescope, 0° angle and a

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 5 Fr 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 NaCl 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. 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 in 1976 [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 telescope of a 2.9 mm diameter, covered with a continuous flow sheath and an operating sheath equipped with a channel for semirigid 5Fr surgical instruments and electrodes (**Figure 4**). The hysteroscope can be introduced into the uterus without cervical dilatation and enables the operative procedure to be performed in outpatient settings. The Bettocchi office hysteroscope with telescope of a 2mm 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, 12° 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). Sometime later a bipolar resectoscopes have been constructed by several manufacturers, including Karl Storz (Tuttingen, Germany) with 22 and 26 Fr diameters, as well as Olympus Corporation (Tokyo, Japan) bipolar resectoscope has an 8.5 mm outer sheath, with a 12° telescope (Figure 5) and Richard Wolf Medical Instruments Corporation (Vernon Hill, USA) princess resectoscope with 21 Fr 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% NaCl and Ringer's lactate, which reduces the risk of hyponatremia and TURP 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 (Ethicon), 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 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 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. The American Food and Drug Administration (FDA) in 2005, approved the use of the first hysteroscopic morcellator “TRUCLEAR” (Smith and Nephew, Andover, MA) (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) 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, Germany) [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.

REFERENCES

1. Russell JB. History and development of hysteroscopy. *Obstet Gynecol Clin North Am.* 1988; 15(1):1–11. PMID: 3050659
2. Magos A. History and evolution of hysteroscopy. In: Shawki O, Deshmukh S, Pacheco LA, editors. *Mastering the techniques in hysteroscopy.* New Delhi, London, Panama: Jaype Brothers Medical Publishers; 2017. p. 8–21. ISBN: 978-93-86150-49-3.
3. Centini G, Troia L, Lazzeri L, Petraglia F, Luisi S. Modern operative hysteroscopy. *Minerva Ginecol.* 2016; 68(2):126–32. PMID:26930389
4. Blanc B, Marty R, Montgolfier R. *Office and operative hysteroscopy.* Paris: Werlag Springer; 2013.(e-Book). ISBN: 978-2-8178-0841-3.
5. Sugimoto O. *A color atlas of hysteroscopy.* Tokyo:Springer-Verlag; 1999. DOI: 10.1007/978-4-431-68391-9. ISBN: 978-4-431-68391-9 (eBook)..
6. Indman PD. Instrumentation and distension media for the hysteroscopic treatment of abnormal uterine bleeding. *Obstet Gynecol Clin North Am.* 2000; 27(2):305–15. PMID:10857121.
7. Valle RF. Development of hysteroscopy from a dream to a reality and its linkage to the present and future. *J Minim Inv Gynecol.* 2007; 14:407–18. DOI: [http://dx.doi.org/10.1016/s1553-4650\(07\)01067-9](http://dx.doi.org/10.1016/s1553-4650(07)01067-9). ISSN: 1553-4650.
8. El Huseiny AM, Soliman BS. Hysteroscopic findings in infertile women: a retrospective study. *Middle East Fertility Society Journal.* 2013; 18(3):154–8. DOI: <http://dx.doi.org/10.1016/j.mefs.2013.04.005>. ISSN: 1110-5680.
9. Neuwirth RS. Hysteroscopy and gynecology: past, present and future. *JMIG.* 2001; 8(2):193–8. PMID: 11342723. DOI: [http://dx.doi.org/10.1016/s1074-3804\(05\)60576-2](http://dx.doi.org/10.1016/s1074-3804(05)60576-2).
10. Batra N, Khnda A, Donovan P. Hysteroscopic myomectomy. *Obstet Gynecol Clin North Am.* 2004; 31:669-85. PMID: 15450327. DOI: 10.1016/j.ogc.2004.06.003.
11. Mazzon I, Favilli A, Cocco P, Crasso M, Horvath S, Bini V, et al. Does cold loop hysteroscopic myomectomy reduce intrauterine adhesions? A retrospective study. *Fertil Steril.* 2014; 101(1):294–8e3. DOI: <http://dx.doi.org/10.1016/j.fertnstert.2013.09.032>.
12. Perino A, Castelli A, Cucinella G, Biondo A, Pane A, Venezia R. A randomized comparison of endometrial laser intrauterine thermotherapy and hysteroscopic endometrial resection. *Fertil Steril.* 2004; 82(3):731–4. DOI: <http://dx.doi.org/10.1016/j.fertnstert.2004.01.045>. ISSN: 0015-0282.
13. Rock JA, Jones III HW. *Textbook of operative gynecology.* 11th ed. Philadelphia: Lippincott Williams & Wilkins; 2015.
14. Esmailzadeh S, Delavar MA, Andarieh MG. Reproductive outcome following hysteroscopic treatment of uterine septum. *Mater Sociomed.* 2014; 26(2):366–71. PMID: 25685079. PMCID: PMC4314157. DOI: 10.5455/msm.2014.26.366-371.
15. Bettocchi S, Ceci O, Nappi L, Di Venere R, Masciopinto V, Pansini V. Operative office hysteroscopy without anesthesia: analysis of 4863 cases performed with mechanical instruments. *J Am Assoc Gynecol Laparosc.* 2004; 11(1):59–61. PMID: 15104833. ISSN: 1074-3804. DOI: [http://doi.org/10.1016/s1074-3804\(05\)60012-6](http://doi.org/10.1016/s1074-3804(05)60012-6).
16. Raimondo G, Raimondo D, Aniello G, Russo C, Ronga A, Gabbanini M, et al. A randomized controlled study comparing carbon dioxide versus normal saline as distension media in diagnostic office hysteroscopy: is the distension with carbon dioxide a problem? *Fertil Steril.* 2010; 94(6):2319–22. PMID: 20079897. DOI: 10.1016/j.fertnstert.2009.11.041.
17. Bettocchi S, Achilare MT, Ceci O, Luigi S. Fertility-enhancing hysteroscopic surgery. *Semin Reprod Med.* 2011; 29(2):75–82. PMID: 21437821. DOI: 10.1055/s-0031-1272469.
18. DiSpiezio Sardo A, Calagna G, Di Carlo C, Guida M, Perino A, Nappi C. Cold loops applied to bipolar resectoscope: A safe „one-step“ myomectomy for treatment of submucosal myomas with intramural development. *J Obstet Gynaecol Res.* 2015; 41(12):1935–41. PMID: 26534903. DOI: 10.1111/og12831.
19. Casadio P, Guasina F, Morra C, Talamo MT, Leggieri C, Frisoni J, Seracchioli R. Hysteroscopic myomectomy: techniques and preoperative assessment. *Minerva Ginecol.* 2016; 68(2):154–66. PMID: 26926414. ISSN: 0026-4784.

20. Johansson J, Lindahl M, Gyllencreutz E, Hahn RG. Symptomatic absorption of isotonic saline during transcervical endometrial resection. *Acta Anaesthesiol Scand*. 2017; 61(1):121–4. DOI: 10.1111/aas.12834. ISSN: 1399-6576.
21. Mencanglia L, Cavalcanti L, Neto A, Alvarez AA. *Manual of hysteroscopy-diagnostic, operative and office hysteroscopy*. Tuttingen: Endo Press; 2013. ISSN: 978-3-89756-409-1.
22. Munro MG, Christianson LA. Complications of hysteroscopic and uterine resectoscopic surgery. *Clin Obstet Gynecol*. 2015; 58(4):765–97. PMID: 26457863. DOI: 10.1097/GRF.0000000000000146.
23. Nappi L, Sorrentino F, Angioni S, Pontis A, Litta P, Greco P. Feasibility of hysteroscopic endometrial polypectomy using a new dual wavelengths laser system (DWLS): preliminary results of a pilot study. *Arch Gynecol Obstet*. 2017; 295(1):3–7. PMID: 27834002. DOI: 10.1007/s00404-016-4232-5.
24. Emanuel MH, Wamsteker K. The intra uterine morcellator: a new hysteroscopic operating technique to remove intrauterine polyps and myomas. *J Minim Invasive Gynecol*. 2005; 12:62–6. PMID: 15904601. DOI:10.1016/j.imig.2004.12.011.
25. Li C, Dai Z, Gong Y, Xie B, Wang B. A systematic review and meta-analysis of randomized controlled trials comparing hysteroscopic morcellation with resectoscopy for patients with endometrial lesions. *Int J Gynaecol Obstet*. 2017; 136(1):6–12. PMID: 28099700. DOI: 10.1002/ijgo.12012.
26. Cohen S, Greenburg JA. Hysteroscopic morcellation for treating intrauterine pathology. *Rev Obstet Gynaecol*. 2011; 4(2):73–80. PMID: 22102930. PMCID: PMC3222940.
27. Lee M, Matsuzono T. Hysteroscopic intrauterine morselation of submucosal fibroids: preliminary results in Hong Kong and comparisons with conventional hysteroscopic monopolar loop resection. *Hong Kong Med J*. 2016; 22(1):56–61. DOI: 10.12809/hkmj154600.
28. Bigatti G, Ferrario C, Rosales M, Baglioni A, Bianchi S. A 4-cm G2 cervical submucosal myoma removed with the IBS^R Integrated Bigatti Shaver. *Gynecol Surg*. 2012; 9(4):453–6. PMCID: PMC3491200. DOI: 10.1007/310397-012-0737-5.



Figure 1. Bozzini's Lichtleiter or light conductor

Paper accepted



Figure 2. Desormeaux's endoscope



Figure 3. Rigid hysteroscope

Paper accepted



Figure 4. Bettocchi office operative hysteroscope

Paper accepted



Figure 5. Olympus bipolar resectoscope

Paper accepted

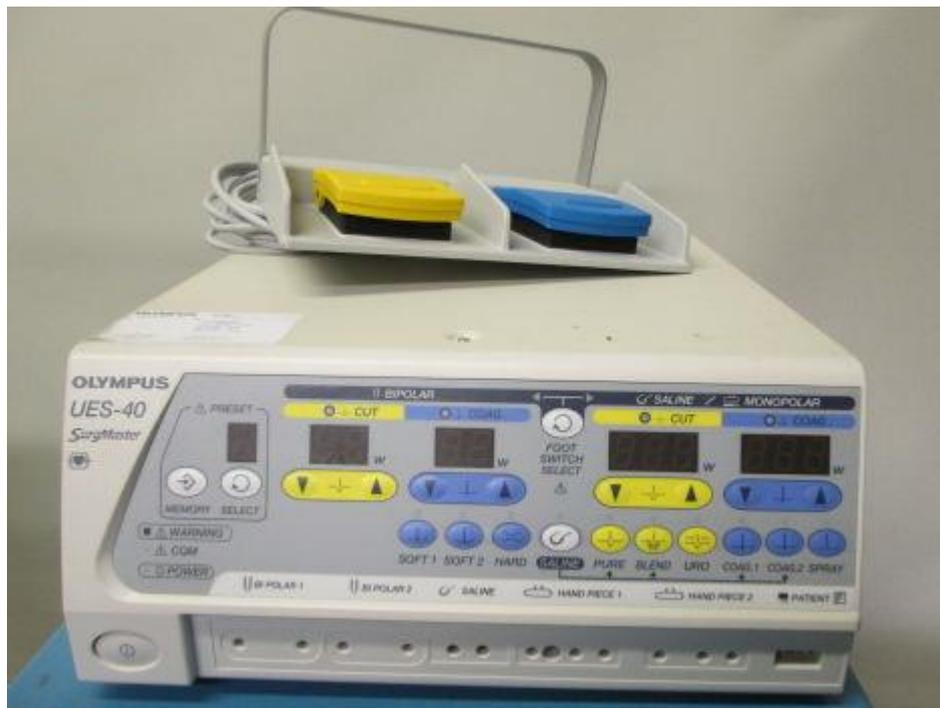


Figure 6. Olympus UES-40 SurgMaster electrocautery unit



Figure 7. TRUCLEAR hysteroscopic morcellator