

Chapter

1

An Introduction to Hysteroscopy

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Over the ages, clinicians have tried to decipher the mysteries of the human body by exploiting natural openings to examine the internal aspects of organs. Since as far back as Hippocrates, a variety of instruments have been employed to achieve this. The simplest form of instrument is a speculum, used to augment natural openings and allow ambient light to illuminate the inner aspect of organs for inspection by the naked eye. While this may be helpful for examining the nostrils or the vagina, for example, it is not an adequate approach for a well-concealed organ such as the uterus. Accurate endoscopic examination of the endometrial cavity, i.e. hysteroscopy, requires the transmission of light into and out of a cavity. Since the endometrial cavity is a potential space, collapsed in the natural state, a distension medium is required to expand the field of vision.

Hysteroscopy today represents nearly three centuries of technical innovations which have facilitated the diagnosis and treatment of pathology related to the uterine cavity [1]. The eighteenth and nineteenth centuries saw innovators of hysteroscopy pioneering principles of safe illumination, intrauterine distension and observation that paved the way for more technological advances in hysteroscopy. This trend has persisted with the continual modification of hysteroscopic techniques and instruments aimed at improving the utility of hysteroscopy as an office-based diagnostic and therapeutic tool.

1.1 The History of Hysteroscopy

The word hysteroscopy takes its origins from the Greek words *hystera* meaning 'uterus' and *skopeo* meaning 'to view' [2]. Hysteroscopy is recognised as the gold standard for uterine cavity assessment and the treatment of endometrial pathology [3]. The initial development of the hysteroscope focused on the process of illumination, intrauterine distension and direct visualisation of the uterine cavity [1, 2].

The first description in modern history of an instrument for artificially illuminating the endometrial cavity was by Andre Levret (1703–1780) in 1743, in Paris [4]. He designed a novel speculum with artificial illumination for the ligation of uterine polyps, but this invention seemed to go unnoticed and unused for another 60 years. The earliest recorded clinical use of an endoscope comes from a German obstetrician and physician of Italian descent, Philipp Bozzini (1773–1809), working in Frankfurt am Main in 1807 [5]. He described a lantern-like instrument containing a wax candle with apertures and mirrors to conduct light into the endometrial cavity and allow its observation. By 1865, continuous improvement in illumination sources, instruments and techniques led to the first endoscopic surgical procedures by Antonin Désormeaux (1815–1894): the visualisation and endoscopic excision of a bladder papilloma [6]. The instrument used by Désormeaux was the first to be called an endoscope. Soon after, still in 1865, Francis Cruise (1834–1912) of Dublin significantly improved upon the endoscope; he modified it by replacing the lamp with petroleum and camphor [7]. It was under his guidance that Diomede Pantaleoni (1846–1878) learnt endoscopic techniques. In 1872, Pantaleoni used the endoscope to see inside the uterine cavity of a woman with post-menopausal bleeding, identified a polyp and managed to cauterise it using silver nitrate, albeit blindly. This is probably the earliest description of operative hysteroscopy [8].

Problems such as poor light transmission, bleeding during uterine instrumentation and difficulties in maintaining uterine distension hindered the practical application and use of the hysteroscope [9–11]. The focus then shifted to contact hysteroscopy, where the uterine endometrium can be visualised on direct contact with the hysteroscope. Two Frenchmen, Simon Duplay and Spiro Clado, published their textbook on hysteroscopy in 1898. Ten years later, Charles David – also working in France – published his master's thesis

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on the diagnosis and treatment of intrauterine diseases [12]. It included several illustrations of polyps, leiomyomas, intrauterine adhesions and retained products of conception. David described the first contact hysteroscope in 1907, and several modifications to it were proposed throughout the early twentieth century [12]. However, development was hampered in cases of continuous bleeding from the endometrium as there were no means to distend the endometrial cavity and expand the field of vision [2]. The consequent lack of panoramic views prevented the complete and accurate assessment of the uterine cavity [1].

It became clear that to gain a panoramic view of the uterine cavity, a safe mechanism for uterine distension was needed. During the first decades of the twentieth century, endoscopic developments were devoted to improving the field of vision [13–15]. Isidor Rubin (1883–1958), an American gynaecologist originating from Prussia, introduced insufflation for uterine distension using carbon dioxide gas [14]. Soon afterwards, in 1925, Harold Seymour, an English gynaecologist from Brighton, built upon Rubin's idea but used saline for irrigation with suction to clear the view [15]. William Norment later modified this in 1957, leading to the development of the modern-day continuous-flow hysteroscopy system [16]. Low-viscosity fluids run the risk of peritoneal spillage, but it was not until 1968 that high-viscosity fluids, such as a 4% solution of Luviskol® K 90, a polyvinylpyrrolidone fluid thickener, became available. Fritz Menken found that using 4% Luviskol® K 90 required a lot less fluid than using low-viscosity fluids like water or saline, and had a much lower risk of peritoneal spillage. However, its yellowish tinge and non-biodegradable nature limited its use [17].

An era of progress followed in operative hysteroscopy for the management of uterine cavity problems. R. Segond is credited with developing the first operative hysteroscope in 1942 with a fully functional fluid irrigation system and fixed optics [18]. Norment and co-workers went on to develop the cutting loop in 1957 [16]; consequently, procedures such as resection of polyps and submucosal fibroids, and electrocoagulation of the intramural portion of the fallopian tubes for sterilisation, became available.

Other notable advances include the development of 'balloon' hysteroscopy in the 1960s, where a balloon was attached to the distal end of the hysteroscope and inflated once inside the uterine cavity [19]. This form of hysteroscopy provided better visualisation of the

cavity and avoided excessive fluid spillage. However, it did not allow concurrent treatment or biopsy, which led to its abandonment in the 1970s [1].

In the second half of the twentieth century, the introduction of cold-light fibre optics by Jacques Vulmière, Max Fourestier and Amedee Gladu revolutionised endoscopy, giving rise to what we would recognise today as the modern hysteroscope [20]. Takaai Mohri and M. Hayashi, later in the 1970s, separately developed and expanded the role of rigid and flexible hysteroscopy by integrating fibre optics [20]. Mohri and colleagues were able to capture good-quality images of the developing fetus (early pregnancy) and the intratubal cavity [21]. The same era saw the successful use of dextran for operative hysteroscopy; Karin Edström and Ingmar Fernström together reported on the safety and efficacy of its routine use during hysteroscopy [22]. Concerns about fluid overload and subsequent complications were addressed by modifying anaesthetic machines and electronic pumps to calibrate inflow rates and pressure in the uterine cavity [1]. At the same time, carbon dioxide was reintroduced as a medium for uterine distension as it had the potential to provide good-quality images in a clean setting with no risk of fluid spillage. However, concerns regarding the risk of death from non-calibrated carbon dioxide use prevailed [23]. In line with these concerns, electronically calibrated equipment was developed to make the use of carbon dioxide safer.

Milton Goldrath and colleagues introduced the Nd:YAG laser for endometrial ablation [24], which was later replaced by electrosurgery. Urological resectoscopes [25] were configured for use in gynaecology. These resectoscopes incorporated electrosurgical cutting loops and 'rollerballs' to remove intracavity pathology and enabled resection or ablation of the endometrial lining. The instruments used monopolar electrical energy, which required the use of non-conducting and hypertonic distension media such as glycine or sorbitol. In the past decade, bipolar resectoscopes have largely replaced the older monopolar systems. The change was driven by safety concerns because bipolar energy allows surgery to be conducted in physiological saline, minimising the risks from intravascular fluid absorption.

During the 1980s and 1990s, hysteroscopes became smaller, with advances in optics, illumination and digital image relay [26]. In addition, the manufacture of miniature ancillary instruments commenced, which

opened the way for a new concept of operating in a conscious patient in an outpatient setting (although the pioneers of the nineteenth century would argue that this was no new concept, given that they performed their original procedures in an ‘outpatient’ setting without anaesthesia!). These instruments were compatible with small-calibre, continuous-flow operating hysteroscopes incorporating 5 or 7 French (Fr) gauge operating channels. Initially, these miniature instruments were restricted to mechanical scissors and a variety of forceps [27], but with the introduction in 1998 of a 5 Fr bipolar electrode (Versapoint®), reliable and efficient electrosurgical cutting of both soft (polyps) and dense (small fibroids) tissue in an outpatient setting became possible for the first time [28, 29]. In addition, the excellent visualisation afforded by modern small-diameter hysteroscopes was also utilised for permanent birth control. Hysteroscopic sterilisation systems designed to be passed along 5 Fr working channels were brought to the market from 2002 (e.g. Ovabloc®, Essure™ and Adiana®) [30–32].

The introduction in 2005 of the first hysteroscopic ‘morcellators’, later renamed hysteroscopic tissue removal systems (HTRs), has impacted hugely on gynaecological practice. The TruClear® system was conceptualised and developed by Mark Hans Emanuel as a mechanical way of removing fibroids and polyps [33, 34]. The novelty of the technology is in its ability to simultaneously cut and aspirate tissue, thereby maintaining a clear visual field. Several large- and small-diameter HTRs are now available for use in both inpatient and outpatient settings.

The growing technological advances in hysteroscopy have helped establish its place as a safe, effective and acceptable procedure in the investigation and treatment of uterine pathology. The current thrust in the development of hysteroscopy seems to focus on portability and disposability, resulting in self-contained hysteroscopic systems with integrated LCD screens, or imaging relayed to laptop computers and smartphones. These easy-to-use, miniature and portable imaging systems, combined with further development of ancillary instruments such as hand-operated HTRs, are enabling hysteroscopy to become a ‘pocket’ outpatient procedure.

1.2 Hysteroscopy and Uterine Cavity Assessment

The drive for technically advanced, portable, miniaturised hysteroscopy equipment has established

hysteroscopy as an outpatient ‘office’ procedure. Outpatient hysteroscopy allows for prompt diagnosis and treatment in a single setting, referred to as the ‘one-stop’ or ‘see-and-treat’ service. It is preferred over inpatient hysteroscopy mainly due to its safety, feasibility and cost-effectiveness without compromise of accuracy [3, 35, 36]. Patient acceptability of outpatient hysteroscopy is also well established [35, 36].

Hysteroscopy assists clinical decision-making and is commonly performed for evaluation and treatment of abnormal uterine bleeding (endometrial hyperplasia, polyps, fibroids etc.), infertility, adhesions and uterine cavity abnormalities [37, 38]. Treatments such as endometrial polypectomy, adhesiolysis, endometrial ablation and submucosal fibroid resection can be safely completed in the same setting, avoiding unnecessary hospital stays and anaesthetic complications. Compared to saline infusion sonography and transvaginal ultrasound, hysteroscopy has greater sensitivity and specificity [39].

1.3 Hysteroscopy and Uterine Cavity Treatment

The introduction of endoscopy into medical practice saw the development of bespoke telescopes, technically modified to allow the exploration of specific body cavities. Further advancement in capabilities such as visualisation and manipulation, alongside the manufacture of compatible or even integrated ancillary equipment, facilitated treatments within a body cavity such that endoscopy was not simply restricted to uterine cavity assessment.

Many of the chapters within this book address therapeutic hysteroscopy for uterine conditions such as abnormal uterine bleeding or particular uterine pathologies (shown in the mini-atlas in Chapter 4) associated with abnormal uterine bleeding or reproductive problems. Diagnosis is still a key aspect of contemporary hysteroscopy, but its versatility as a treatment modality in both an inpatient (anaesthetised patient) and outpatient (conscious patient) setting has established hysteroscopy in modern gynaecology. This book details the key information, such as indications, equipment, infrastructure, technical skills and clinical evidence, needed to practise hysteroscopy proficiently and achieve optimal clinical outcomes.

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References

1. Valle R. Development of hysteroscopy: from a dream to a reality, and its linkage to the present and future. *J Minim Invasive Gynecol* 2007; **14**: 407–18.
2. Sardo A, Calagna G, Di Carlo C. Tips and tricks in office hysteroscopy. *Gynecol Minim Invasive Ther* 2015; **4**: 3–7.
3. Clark T, Voit D, Gupta J, et al. Accuracy of hysteroscopy in the diagnosis of endometrial cancer and hyperplasia. *JAMA* 2002; **288**: 1610.
4. Nezhat C. History of endoscopy. Chapter 4: Hovering on the brink of modernity. Online blog. https://laparoscopy.blogs.com/endoscopyhistory/chapter_04 (accessed November 2019).
5. Pearlman SJ. Bozzini's clinical treatise on endoscopy: a translation. *Q Bull Northwest Univ Med Sch* 1949; **23**: 332–54. Originally published in German as: Bozzini P Der Lichtleiter oder die Beschreibung einer einfachen Vorrichtung und ihrer Anwendung zur Erleuchtung innerer Höhlen und Zwischenräume des lebenden animalischen Körpers. Weimar: Landesindustriecompoirs; 1807.
6. Desormeaux AJ. *De l'endoscope et de ses applications au diagnostic et au traitement des affections de l'urèthre et de la vessie*. Paris: Baillière; 1865.
7. Cruise FR. The utility of the endoscope as an aid in the diagnosis and treatment of disease. *Dublin Q J Med Sci* 1865; **39**: 329–63.
8. Pantaleoni DC. On endoscopic examination of the cavity of the womb. *Med Press Circular* 1869; **8**: 26–7.
9. Lindemann HJ. Historical aspects of hysteroscopy. *Fertil Steril* 1973; **24**: 230–42.
10. Porto R. *Hystérocopie*. Paris: Searle of France; 1975. Conception et réalisation Elpe/Paris.
11. Nitze M. Eine neue Beleuchtungs und Untersuchungsmethode für Harnrohre, Harnblase, und rectum. *Wien Med Wochensh* 1879; **29**: 645–52.
12. David C. Endoscopie de l'utérus après l'avortement et dans les suites de couches normales et pathologiques. *Soc Obstet Paris* 1907; **10**: 288–97.
13. Heineberg A. Uterine endoscopy: an aid to precision in the diagnosis of intra-uterine disease. A preliminary report, with the presentation of a new uteroscope. *Surg Gynecol Obstet* 1914; **18**: 513–15.
14. Rubin IC. Uterine endoscopy, endometrosopy with the aid of uterine insufflation. *Am J Obstet Gynecol* 1925; **10**: 313–27.
15. Seymour HF. Endoscopy of the uterus: with a description of a hysteroscope. *J Obstet Gynecol Brit Emp* 1926; **33**: 52–5.
16. Norment WB, Sikes CH, Berry FX, Bird J. Hysteroscopy. *Surg Clin North Am* 1957: 1377–86.
17. Menken FC. Endoscopic observations of endocrine process and hormonal changes. In Ruiz-Albrecht F, Ramirez-Sanchez J, Willowitz H, eds., *Simposio Sobre Esteroides Sexuales. Proceedings of the Simposio Sobre Esteroides Sexuales. Museo Nacional, Bogota, Colombia, June 24–26, 1968*. Berlin: Saladruck; 1969: 276–81.
18. Segond R, L'hystérocopie: état actuel de sa technique et son emploi clinique. *Sem Hop Paris* 1942; **9**: 215–16.
19. Silander T Hysteroscopy through a transparent rubber balloon. *Surg Gynecol Obstet* 1962; **114**: 125–7.
20. Vulmière J, Fourestier M, Gladu A. Hystérocopie de contact. Perfectionnement à L'endoscopie médicale. *Presse Médicale* 1952; **60**: 1292.
21. Mohri T, Mohri C, Yamadori F. Tubaloscope flexible glassfiber endoscope for intratubal observation. *Endoscopy* 1970; **4**: 226–30.
22. Edstrom K, Fernstrom I. The diagnostic possibilities of a modified hysteroscopic technique. *Acta Obstet Gynecol Scand* 1970; **49**: 327–30.
23. Porto R, Serment H. Pneumo-hystérocopie. *Gynecol Med Fr* 1973; **80**: 4985–8.
24. Goldrath MH, Fuller TA, Segal S. Laser photovaporization of endometrium for the treatment of menorrhagia. *Am J Obstet Gynecol* 1981; **140**: 14–19.
25. Iglesias JJ, Sporer A, Gellman AC, Seebode JJ. New Iglesias resectoscope with continuous irrigation, simultaneous suction, and low intravesical pressure. *J Urol* 1975; **114**: 929–33.
26. Hamou JE. Microhystérocopie: une nouvelle technique en endoscopie, ses applications. *Acta Endoscopica* 1980; **10**: 415–22.
27. Bettocchi S, Ceci O, Nappi L, et al. Operative office hysteroscopy without anesthesia: analysis of 4863 cases performed with mechanical instruments. *J Am Assoc Gynecol Laparosc* 2004; **11**: 59–61.
28. Bettocchi S, Ceci O, Di Venere R, et al. Advanced operative office hysteroscopy without anaesthesia: analysis of 501 cases treated with a 5 Fr bipolar electrode. *Hum Reprod* 2002; **17**: 2435–8.
29. Clark TJ, Godwin J, Khan KS, Gupta JK. Ambulatory endoscopic treatment of symptomatic benign endometrial polyps: a feasibility study. *Gynaecol Endosc* 2002; **11**: 91–7.
30. Huvar, I, Tinga D, Pilka L. Hysteroscopic sterilization using Ovabloc. *Ceska Gynecol* 1994; **59**(4): 193–5.
31. Valle RF, Cooper JM, Kerin JF. Hysteroscopic tubal sterilization with the Essure no incisional permanent contraception system. *Obstet Gynecol* 2002; **99**(suppl): S11.
32. Palmer SN, Greenberg JA Transcervical sterilization: a comparison of Essure® permanent birth control

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- system and Adiana[®] permanent contraception system. *Rev Obstet Gynecol* 2009; **2**: 84–92.
33. 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.
34. Smith PP, Middleton LJ, Connor M, Clark TJ. Hysteroscopic morcellation compared with electrical resection of endometrial polyps: a randomized controlled trial. *Obstet Gynecol* 2014; **123**: 745–51.
35. Cooper NAM, Barton PM, Breijer MC, et al. Cost-effectiveness of diagnostic strategies for the management of abnormal uterine bleeding (heavy menstrual bleeding and post-menopausal bleeding): a decision analysis. *Health Technol Assess* 2014; **18**(24): 1–201.
36. Moawad NS, Santamaria E, Johnson M, Shuster J. Cost-effectiveness of office hysteroscopy for abnormal uterine bleeding. *JSLs* 2014; **18**.
37. Di Spiezio Sardo A, Bettocchi S, Spinelli M, et al. Review of new office-based hysteroscopic procedures 2003–2009. *J Minim Invasive Gynecol* 2010; **17**: 436–48.
38. Mahmud A, Smith P, Clark J The role of hysteroscopy in diagnosis of menstrual disorders. *Best Pract Res Clin Obstet Gynaecol* 2015; **29**: 898–907.
39. Grimbizis GF, Tsolakidis D, Mikos T, et al. A prospective comparison of transvaginal ultrasound, saline infusion sonohysterography, and diagnostic hysteroscopy in the evaluation of endometrial pathology. *Fertil Steril* 2010; **94**: 2720–5.

Hysteroscopy is the inspection of the uterine cavity by endoscopy with access through the cervix. It allows for the diagnosis of intrauterine pathology and serves as a method for surgical intervention (operative hysteroscopy). A hysteroscope is an endoscope that carries optical and light channels or fibers. It is introduced in a sheath that provides an inflow and outflow channel for insufflation of the uterine cavity. In addition, an operative channel may be present to introduce scissors, graspers or