Hysteroscopy: Techniques, Technology, and Controversies

THIERRY G. VANCAILLIE, M.D.
CENTER FOR GYNECOLOGIC ENDOSURGERY
SAN ANTONIO, TEXAS

Hysteroscopy is a procedure with a century-long history, yet it may be said that few gynecologists actually have a hysteroscopy set-up in their office. At the same time, however, it would be surprising to find a urologist's office devoid of cystoscopy equipment.

There are two main reasons for this. First and foremost, the traditional Ob–Gyn office is of the primary care type, i.e., with a high patient turnover. Hence the physician in such a setting can usually not set aside sufficient time for procedures of any kind. Even colposcopy is not available in every gynecologist's office. Political, economic, and social vectors will have to converge before a substantial number of Ob–Gyn offices will become more procedure-oriented. The second reason for lack of interest in hysteroscopy is the absence of a "second step." A procedure which remains purely diagnostic does not have a bright future. Laparoscopy has become important due to the fact that it has allowed tubal ligation to be performed. Subsequently, development of other procedures has benefited substantially from the availability of laparoscopic techniques. A similar future might be in sight for hysteroscopy. Endometrial ablation in its diverse forms may indeed become the "second step" procedure which will finally bring hysteroscopy into the office of every gynecologist.

OFFICE HYSTEROSCOPY

The ideal office hysteroscopy setting comprises a rigid endoscope of approximately 3- to 5-mm outer diameter, with CO_2 insufflation as distention medium. The advantage is the relative simplicity of the set-up which keeps maintenance, "down time," and costs low. The disadvantage is that the procedure cannot be performed in the presence of bleeding, nor can any manipulation be performed. Flexible hysteroscopes did not become popular despite the fact that they offer real-time biopsy possibilities. Higher costs and the relative fragility of the equipment are the main road blocks to increased use. More recently manufacturers have agreed to produce continuous flow systems for rigid telescopes of a small outer diameter. This may well become the long-awaited breakthrough.

Continuous flow with fluid distention media will allow intrauterine manipulation such as tubal catheterization, polypectomy, and so on. Even small fibroids could be removed this way. The disadvantage is the use of fluid media and fluid overload in the office. The use of fluid media introduces a new variable and is not welcomed by the office personnel. The question regarding the limits of office hysteroscopy arises. Additional new variables such as local anesthesia and administration of intravenous fluids including analgesia are to be dealt with. Every gynecologist will have to assess for himself or herself whether venturing into office procedures will be a risk worth taking. Ultimately, continuous flow systems allow the "second step" procedure that brings hysteroscopy beyond a purely diagnostic modality.

Vaginal sonography replaces hysteroscopy to a certain extent. However, both technologies have more to offer if used in a synergistic fashion. Ultrasonography provides anatomic information beyond the uterine cavity, although in less detail. Hysteroscopy is limited to the intracavitary findings but also allows manipulation within that cavity. Ultrasonography has taken away the purely descriptive aspect of hysteroscopy; hysteroscopy remains, however, the preferred method of access for intrauterine manipulation.

OFFICE ENDOMETRIAL ABLATION

Several new technologies are emerging. Using different means, they have the common goal of destroying the endometrium to reduce menstrual flow. Energy modalities used range from photoenergy (laser) to cold liquids. It appears that three modalities emerge with potential for widespread use in the office setting. (1) The simplest method, in direct continuity with the potential of continuous flow hysteroscopes, is a method championed by Goldrath. He advocates the use of hot distention medium under direct visualization. Provided the intrauterine pressure is low, the hot medium will remain within the cavity.

(2) Another method consists of using hot liquid in a blind fashion. This method is commonly known as the "hot water balloon" (Gynecare, Menlo Park, Calif.). In both methods, fluid is heated to a predetermined temperature. Relying on laboratory data of heat transfer in tissue, this temperature is maintained for a preset time–approximately 6 to 8 minutes. (3) The third method currently under investigation is the multi-electrode balloon (Vesta Medical, Mountain View, Calif., Figs. 1, 2). In this method, multiple electrodes are brought in contact with the endometrium and activated until a preset temperature is uniformly reached. Each electrode is monitored separately by a temperature sensor. Electrical energy is applied only in order to maintain the predetermined temperature for a preset period of time.

Other technologies such as high-frequency ("microwave") probes, liquid nitrogen, and laser diffusers are being tested. Although they are appealing in many aspects, there are major hurdles for the latter technologies to overcome before they can be widely accepted. The No. 1 issue is cost. Unless laser technology becomes more cost-effective as a result of use in disciplines outside the medical field, there is little chance for this technology to be able to compete successfully with electrosurgery in the office setting. Safety may be an issue which could play to the advantage of laser technology. It is reasonable to expect that the destruction of the endometrium with photons will be selective and therefore presumably safer than any other kind of energy. However, it is unknown how much the community will be willing to pay for such safety.

The days when the word "laser" could successfully launch a new product on its own are over. Cost-effectiveness is, quite rightfully, today's buzzword. Hot fluid and electrosurgery are inexpensive. In addition to this economical advantage, the balloon technologies are simple to use and require a minimal amount of hardware, which provides them with excellent mobility.

Endometrial ablation in itself remains a controversial subject. Historically endometrial ablation goes back to the 1930s, the heyday of electrosurgery. Large, long electrical probes, originally designed for hemostasis during tonsillectomy, were introduced into the uterus, activated, and blindly moved around. This procedure was quite successful in the treatment of acute hemorrhage in women in their perimenopausal years. Bardenheuer[1] in Germany advocated that electrocoagulation of the endometrium was a safe and economically sound method to treat menometrorrhagia. Considering the high mortality associated with hysterectomy at the time, he certainly was correct. Progress in anesthesia and surgical techniques pushed endometrial ablation into oblivion during and after World War II. Hysterectomy is technically a relatively simple procedure, a fact which certainly played a role in bringing the number of procedures up to half a million a year in the United States alone.

"Whatever is wrong with the uterus, take it out" is an attitude that has to change before endometrial ablation will become an accepted alternative to hysterectomy. This change is being implemented by the increasing involvement of the patient. Patients demand treatment modalities which allow them to retain the uterus. In general terms such procedures can be called "uterus-sparing surgery." The demand for endometrial ablation will go hand in hand with the level of education, understanding, and sophistication of the patient. In many communities, endometrial ablation has already gained its rightful place among the plethora of possible treatment modalities for abnormal uterine bleeding. It is surprising that many gynecologists still consider a curettage to be a therapeutic procedure, whereas it has clearly been shown to have no therapeutic effect whatsoever. On the other hand, the same gynecologist will refuse to admit that endometrial abla-

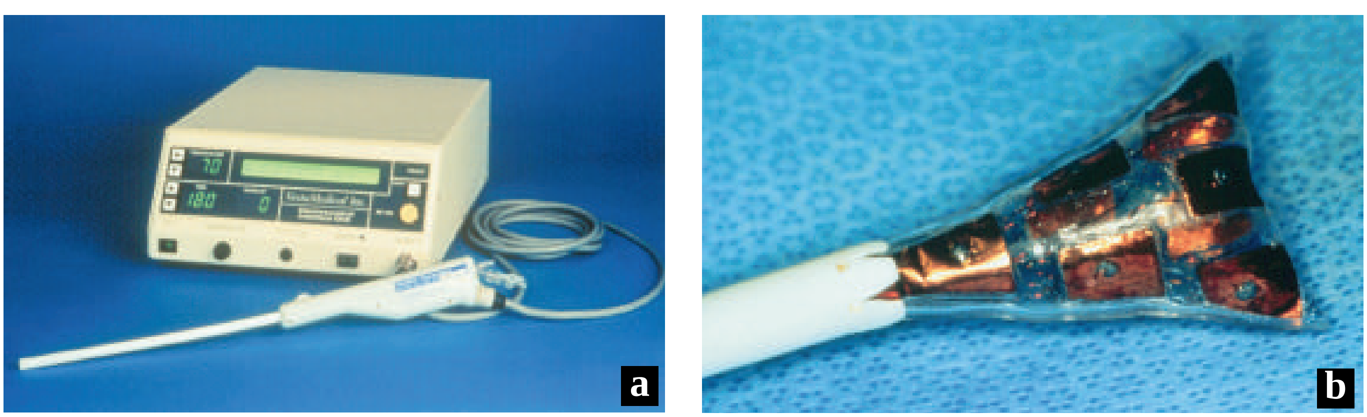

Figure 1. VestaBlate system. (a) This illustration shows the control unit and the disposable insert. (b) The balloon, when deployed, displays the six electrodes on one side.

tion is a therapeutic procedure, although it is clearly demonstrated that most patients experience reduced bleeding following the surgery.[2] Once the technology will have simplified the procedure to the point that it becomes a true office procedure, we will see a lot of converts.

OPERATIVE HYSTEROSCOPY

Even with a shift toward the office for endometrial ablation, operative hysteroscopy will continue to evolve. The main force is the demand by the patient for uterus-sparing procedures. Ironically, procedures such as myomectomy (Fig. 3), which are already available, will not advance and be readily available as quickly as office endometrial ablation because these procedures require much more skill. Operative hysteroscopy is important, however, because it allows us to learn more about the micro-anatomy of the uterus. It is time for us to learn about the in vivo aspects of pathologic conditions such as adenomyosis (Fig. 4). Correlations between the hysteroscopic findings, ultrasonographic findings, and clinical data need to be established. Once such basic information will become available, conservative treatment of these pathologic conditions will become accessible for evaluation.

Progress is being made in three areas: fluid monitoring, electrode design, and tissue removal. Fluid monitoring is most important due to the potential complications of overload, hyponatremia, and eventually cerebral edema. An important aspect in managing fluid overload is the correct choice of fluid distention medium. Also important are devices to monitor the fluid loss. Fluid-monitoring devices are already available in Europe. These devices comprise a pumping mechanism which is controlled by the resistance to flow and a suction canister, the volume of which is measured by weight. Measurement of intrauterine pressure may seem important but is certainly difficult to obtain.

In most devices, the actual intrauterine pressure is estimated by resistance to flow. In a large cavity, such as the bladder, this approximation may hold, but not in the uterus. The devices relying on pressure feedback are somewhat too complex and cumbersome. Other devices are relying solely on the weight of the fluid. Because all fluid used is theoretically recuperated, the sum of inflow and outflow should remain the same throughout the procedure. Measuring the combined weight of in- and outflow fluids gives a fair estimate of the fluid lost. The author is involved in the design of such a device (Aquintel, Longmont, Colo.). This simple instrument provides the surgeon with real-time information on how much fluid is not returned to the collection system. That non-collected fluid can be on the floor, in the tubing, on the drape, or in the patient. It remains the surgeon's responsibility to find out where the fluid has gone.

That intrauterine pressure of the distention medium is related to fluid overload is certain. In an intact uterus, the migration of fluid through the mucosa will be directly related to the gradient of fluid pressures between the intrauterine compartment and the interstitial compartment, which is directly dependent on the mean arterial pressure. In addition, there is the resistance of an intact cell membrane of the mucosa. The resistance of this membrane is hormone-dependent. It is well known that intravasation of contrast material during hysterosalpingography is more likely to happen during the luteal phase as compared to the proliferative phase. Without surgical manipulation, it is quite unlikely that distention medium will enter the bloodstream in great quantities because of the mucosal barrier. Cervical lacerations which occurred during dilatation remain a source of fluid overload, however. Spillage of the distention medium through the tubal ostium into the peritoneal cavity does occur. The importance of this spillage is dependent on

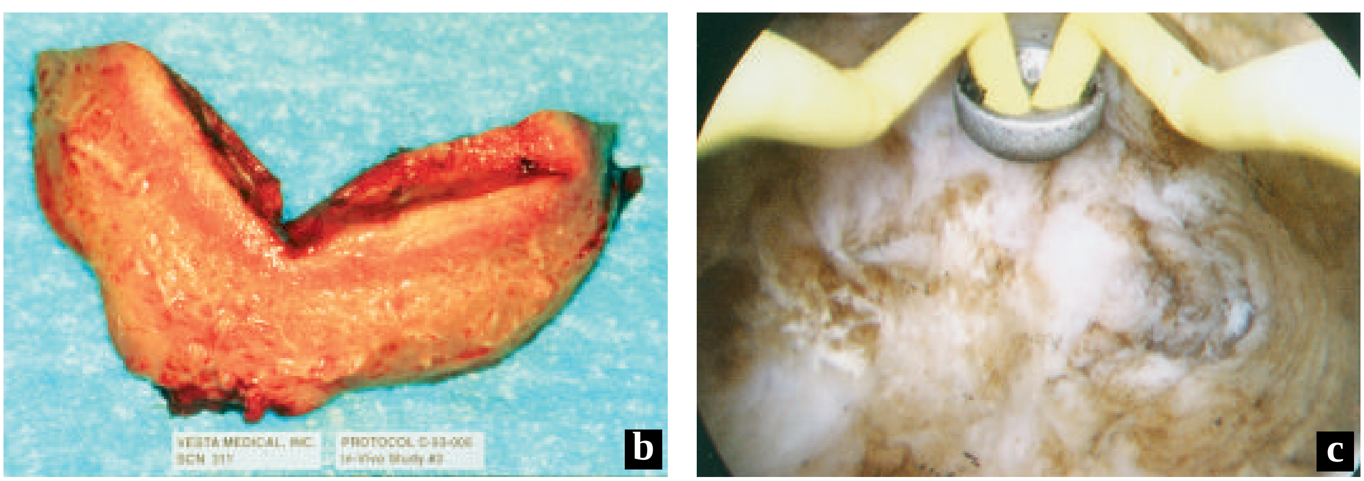

Figure 2. (a) Extirpated uterus specimen, obtained after in vivo use of the VestaBlate electrode. A uniform blanching of the endometrial surface is observed. (b) Transverse section through a freshly obtained specimen, shows the uniform and deep (2 to 4 mm into the myometrium) thermal injury. (c) In vivo view after "conventional" ablation, using a combination technique of loop and rollerball electrodes. The thermal damage is irregular, as testified by the various degrees of carbonization.

Figures 3a-c. Myomectomy.

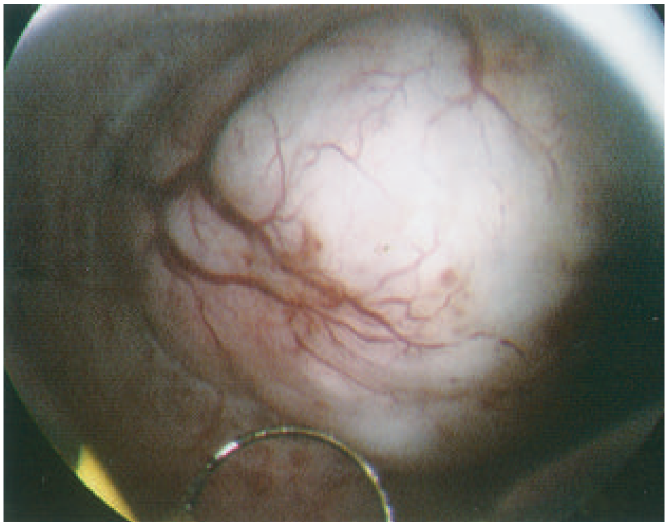

Figure 3a. Initial view of the submucous fibroid, which is inserted in the fundal area, above the right tubal ostium.

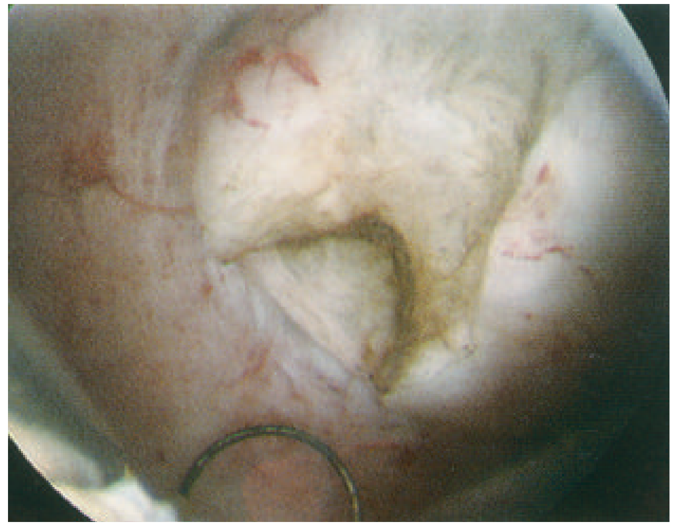

Figure 3b. View after the first cut, deeply in the middle of the fibroid.

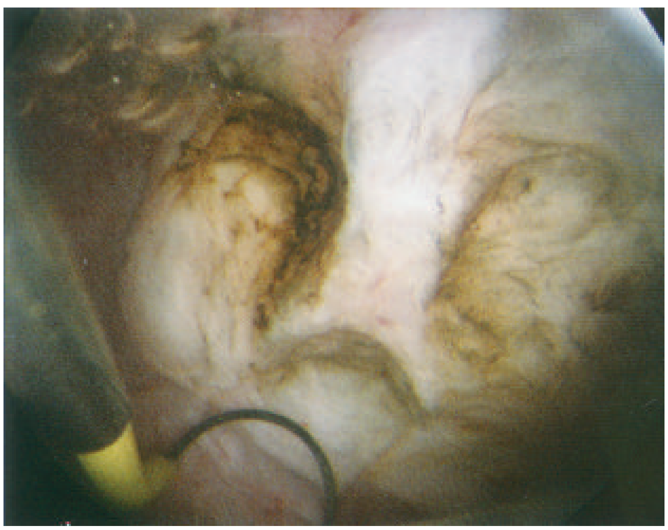

Figure 3c. View after the second and third cuts, along the sides of the fibroid. Continuing this sequence of central and lateral cuts, the fibroid is eventually completely resected.

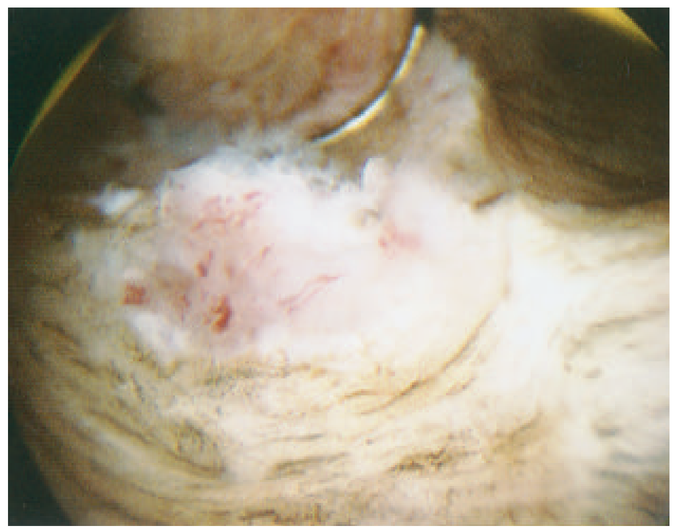

Figure 4. Adenomyosis. The cutting loop uncovers an isolated island of endometrial tissue, encased within the myometrium. The presence of endometrial glandular tissue within the myometrium has different appearances, the significance of which is unknown.

the intrauterine pressure and the closure pressure of the ostium, which is mainly determined by the hormone environment. However, the impact of transtubal migration of fluid on the electrolyte homeostasis of the patient is chronic, rather than acute. A hypo-osmolar fluid in the peritoneal cavity will slowly diffuse into the bloodstream and cause dilution. A patient with normal kidney filtration capability should be able to eliminate this free water.

Theoretically, one could monitor vascular pressures and tailor the intrauterine pressure accordingly. When performing operative hysteroscopy, the mucosal barrier is absent. Mechanical dilation of the cervix to a larger diameter and surgical sectioning of tissue dramatically change the hydrodynamic conditions, depending on the vascular system involved. If a large vein is transected during myomectomy, or lacerated during cervical dilation, the distention fluid will flow into the vascular system of the patient, as if there were a large bore intravenous catheter going full speed. In such conditions, it is important to know the difference between in- and outflow volumes without delay. Pressure readings are worthless because the venous intravascular pressure is only a few centimeters of water, well below the minimum distention pressure of the uterus.

When performing an endometrial resection, there are no large veins involved, but resection will give direct access for the distention fluid to enter the capillary and arteriolar vascular network. There again, the rate of fluid overload will depend directly on the gradient between the intrauterine fluid pressure and the intravascular pressure. There is a simpler method to evaluate gradient than measuring pressures. When the pressure in the cavity is greater than in the capillary bed, then the fluid enters the vascular network, and the field of view is clear as water, not a single red blood cell to see. When the pressure in the capillary network is greater than the pressure in the uterine cavity, then the transected vessels will bleed. By varying the height of the column holding the distention medium supply, the surgeon can select the inflow pressure, which provides a good view, but does not completely stop capillary bleeding. The author favors this "surgical" approach to fluid overload prevention over a complex algorithm of pressure measurements.

New electrodes for use with the resectoscope are available or in development. The designs are aimed at improving the surgeon's ability to desiccate, cut, or vaporize. A barrel-shaped electrode with deep grooves relies on concentration of the electrical energy on the edges between the grooves. The electrodensity there is high enough to vaporize tissue (Circon, ACMI). Then there are loop electrodes which cut to a predetermined depth using a variety of technical artifacts to prevent the electrode from penetrating into tissue further.

Lastly, research is underway in the domain of improved tissue removal. Everyone involved in operative hysteroscopy has experienced the frustration of having to interrupt the procedure because of tissue chips preventing visualization or access to a particular area of the uterus. FemRx, a company in Palo Alto, California, is currently experimenting with a different sheath design for the resectoscope that would allow real-time evacuation of tissue chips. STI

REFERENCES

1. Bardenheuer FH. Elektrokoagulation der uterusschleimhaut zur behandlung klimakterischer blutungen. Zentralblatt Gynaekologie 1937;59:209-16.
2. Loffer F. Endometrial Ablation–Where do we stand? Gynecol Endosc 1992;1:175-9.