The HysteroTrainer, a Simulator for Diagnostic and Operative Hysteroscopy

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Abstract

Hysteroscopy has become an integral part of operative gynecology, with rates of major complications of 1%. To avoid serious, even lethal, complications, an intensive, well-structured training program for practicing surgeons is necessary. In response to these educational requirements, the HysteroTrainer was developed to provide in vitro simulation training for diagnostic and operative hysteroscopy, including laser and high-frequency electrosurgery.

Hysteroscopy, diagnostic and operative, is one of the two pillars of minimally invasive therapy in gynecology. It is a nontraumatic method with a wide spectrum of indications, and often may be performed on an ambulatory basis. Results of hysteroscopic procedures are at least comparable to those of conventional procedures.

Although overall complication rates of 2% and rates of major complications of 1% are very low, serious to lethal complications, such as carbon dioxide gas embolism, fluid overload due to pulmonary edema, and uterine perforations are described in the literature. To prevent these complications, an intensive well-structured training program is the major prerequisite for performing hysteroscopic procedures.

Diagnostic hysteroscopy is relatively uncomplicated from a technical point of view; however, training is necessary to differentiate between normal findings and pathologic findings, especially through video. Surgical hysteroscopy, with conventional sharp instruments, electrosurgery or laser technique, requires still more intensive practice. The HysteroTrainer, an in vitro simulation trainer for diagnostic and operative hysteroscopy, was developed to meet these educational requirements. In addition, it may be useful for practicing distending the uterine cavity and working with the continuous-flow suction and irrigation system; establishing spatial videoscopic orientation within the uterine cavity; recognizing and classifying intrauterine pathology; performing various operative hysteroscopic procedures from simple biopsies to electroresection with electrodes, loops, or rollerball, and laser techniques; controlling the safety of the equipment; and providing patient information.

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Dr. Wallwiener is the inventor of the instrument. The manufacturer is Schuran Company, Jülich, Germany.

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The HysteroTrainer

The HysteroTrainer (Figure 1) is an integrated system consisting of two plates that can be closed by an air-tight, waterproof clamping mechanism. The lower plate includes an outline of internal female genitalia, and depressions in which one may insert an artificial uterine cavity. An opening in the upper part of the uterus model is covered with a thin neoprene membrane, so that distention up to a defined intrauterine pressure of 100 to 150 mm Hg can be simulated. The cervix and the cervical canal are constructed of flexible material and can be adapted to suit the diameter of all available diagnostic and operative hysteroscopes. Students can practice inserting various hysteroscopes and videohysteroscopes. The external cervical os enables attachment of commercial clips for manipulating the cervix in various directions. A vacuum bell for closing the cervix is also available.

The interior of the uterus is anatomically accurate, thus enabling surgeons to learn to become visually oriented in the small uterine cavity. Silicone models representing various intrauterine disease processes can be used to train for diagnostic hysteroscopy. Modules are also available that permit mounting in vitro tissue specimens, as well as clamp fixation of hysterectomy specimens, for acquiring proficiency in operative hysteroscopic procedures.

Uses of the Instrument

Diagnostic hysteroscopy with thin instruments requires practice. In addition, it is not easy to master identification of pathologic changes in the uterus through the videohysteroscope. Using various models representing pathologic conditions, each with its characteristic endometrial lining, the physician can learn the difference in appearance of submucous myomata, mucous polyps, malformations of the uterus, intrauterine synechiae, and intrauterine devices in normal and pathologic locations. A special insert with fallopian tubes (FallopoTrainer) allows simulation of tubal catheterization, falloposcopy, and tuboscopy.

Operative hysteroscopy is more difficult than diagnostic hysteroscopy. The surgical hysteroscope has a greater outer diameter, and several working channels are available for insertion of surgical instruments, including electrodes to the electrosurgical loop and laser fibers. Also operative manipulation inside the uterine cavity may present difficulties. In addition to distention of the cavum uteri, a continuous-flow system for irrigation and suction is necessary to ensure clear vision and removal of debris. The HysteroTrainer allows the student to practice with this equipment and achieve expertise (Table 1).

By working with in vitro specimens or silicone models, the surgeon can be trained in intrauterine manipulations, cutting, and coagulation under conditions similar to in vivo applications. All surgical instruments can be employed: monopolar and bipolar cutting electrodes, the hysteroscopic resectoscope, loops, rollerball, neodymium:ytrrium-aluminum-garnet laser fibers, scissors, coagulation forceps, biopsy forceps, and scissors.

<table>
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<th>Learning Phase</th>
<th>Procedures to Be Practiced</th>
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<tr>
<td>1</td>
<td>Insertion of the operative hysteroscope, spatial orientation, videoendoscopy</td>
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<td>2</td>
<td>Gas distention of the cavity</td>
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<td>3</td>
<td>Liquid distention of the uterine cavity and application of the continuous-flow system</td>
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<td>4</td>
<td>Simulation of septum resection on in vitro specimens with high-frequency electrodes, laser fibers, and scissors</td>
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<td>5</td>
<td>Simulation of electrolaser resection of myomata on silicone models</td>
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<td>6</td>
<td>In vitro simulation of endometrial ablation with the electroresector (loop, rollerball)</td>
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<td>7</td>
<td>Coagulation (forceps, laser) on bodylike preparations</td>
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and scalpel (Figures 2 and 3). With a posthysterectomy uterus specimen, all steps of diagnostic and operative hysteroscopy can be simulated.

Videoendoscopy has become indispensable in modern hysteroscopy. Even physicians who are experienced in hysteroscopy must adapt when performing videoendoscopy, since they are accustomed to looking directly through the hysteroscope into the interior of the uterus. When performing videoendoscopy, they see a two-dimensional image on the monitor, and must master processing it into a three-dimensional image in their mind. This can be practiced with the Hystero-Trainer.

Even for experts the HysteroTrainer may be useful for performing a safety check of equipment, starting with insufflation and distention systems, to lasers, and high-frequency electrosurgical equipment. Moreover, it is well suited for testing new or unfamiliar equipment.

Finally, the instrument is excellent for demonstrating to patients the type of procedure they are about to undergo.

Summary

In accordance with the trend to minimally invasive surgery, hysteroscopy is gaining increasing importance in gynecologic surgery. It is essential that surgeons have the best available equipment, excellent training and expertise, and knowledge of safety aspects to prevent serious complications. The HysteroTrainer offers a practical and safe method for training physicians in the entire spectrum of diagnostic and operative hysteroscopy, including laser and high-frequency electrosurgical techniques.

References