

Get “Real” with Hysteroscopy Using the Pig Bladder: A “Uterine” Model for Hysteroscopy Training

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Abstract

Introduction: This study aimed to develop a realistic and lifelike uterine model for the training of hysteroscopy skills. **Materials and Methods:** A lifelike “uterine” model was constructed using female pig bladder. The pig bladder was enclosed within a malleable mould, with both ureters blocked by pins. Both rigid and flexible hysteroscopes were used in this study. **Results:** Basic diagnostic hysteroscopy can be performed in the usual fashion using this lifelike model. The cost of each learning station is minimal. Pig bladder accurately simulates the human uterus with its realistic tactile feel, and conditions in the surgical environment, including obscuration of vision by debris, uterine “folds”, realistic “ostia”, incomplete shearing of tissue, “uterine” perforation, etc. **Conclusion:** This low-cost novel model provides realistic tissue resistance and yields an almost anatomically accurate hysteroscopic training tool, thereby allowing trainees to effectively acquire both diagnostic and therapeutic hysteroscopic skills.

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Introduction

Hysteroscopy is an important surgical component of any training programme in gynaecology. Traditionally, surgical training in hysteroscopy occurred in the operating room where trainees first observe their senior performing the procedure, and then take on increasing roles in surgical cases under direct supervision.¹ Often, hysteroscopic skills are acquired via a “see one, do one, teach one” basis, with increasing refinement and mastery of the technique as one performs more of such procedures.²

In recent years, due to ever increasing medico-legal issues, the major shift in medical training has been towards the use of simulation on computers and inanimate simulators. Although simulation allows the opportunity for repeated practice, feedback and ability to learn without causing harm, it is still far from being realistic.³ It is unable to replicate actual tissue elasticity, resistance and tactile feel, and also intra-operative conditions, such as obscuration of vision due to debris floatation.

A review of existing literature revealed a paucity of soft tissue models that could be used for hysteroscopy training.⁴⁻⁶ In this paper, we propose using pig bladder as a novel “uterine” model for hysteroscopy training. This paper describes the design of a training model for acquisition of both diagnostic and therapeutic hysteroscopic skills.

Materials and Methods

Fourteen specialist trainees from the Department of Obstetrics and Gynaecology at the National University Hospital, Singapore, participated in this study. It was a half day course whose goals were for trainees to acquire the skills of basic diagnostic hysteroscopy, as well as to be exposed to the procedure of transcervical resection of endometrium using resectoscope.

This study involved the development of a pig bladder model to mimic a human uterine cavity. After completing the procedural training protocol approved by the Institutional

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Animal Care and Use Committee (IACUC), the pig bladder and its ureters were harvested from a euthanised pig under a shared tissue programme.⁷

The “uterine model” was set up before being presented to trainees as shown in Figure 1. The pig bladder was enclosed in a malleable mould created from Plasticine™. The use of Plasticine™ was ideal as it allowed the bladder to expand during saline insufflation. Both ureters were blocked using pins, thereby allowing the bladder to expand with normal saline. The setup was then placed on top of a table covered by plastic sheet with a pail below it to allow the saline to drain (Fig. 1). Two hysteroscopy stations—one using rigid hysteroscopy and the other using flexible hysteroscopy, were set up for the training. Both the rigid and flexible hysteroscopy stations were provided by Olympus® for training purposes. The cost of each station was minimal as each component was easily available.

The course began with a 1-hour didactic lecture covering surgical indications, contraindications, anticipated complications, and basics of equipment and media options, followed by a 3-hour hands-on session where trainees were given an opportunity to assemble the diagnostic and operative hysteroscopes and review troubleshooting points in their use, as well as the use of other endoscopic equipment such as camera, light source and flexible hysteroscope.

The Olympus® TCRis resectoscope (outer diameter 8.5 mm) was used to perform the transurethral resection of the urothelium surface of the pig bladder. The Olympus® UES-40 (SurgMaster UES-40 with TCRis resectoscope) enabled trainees to perform TCRis resection using normal saline. The bipolar and saline system effectively avoided the need for earthing and plating the pig bladder during resection. Images were transmitted and displayed on the VISOER PRO ENDOALPHA Olympus® integrated endosurgery system

that displayed high-definition TV images. The HYF-XP Olympus® (ultraslim 3.1 mm insertion tube) was used as the flexible hysteroscope.

Results

The “uterine” model setup facilitated instructions in basic hysteroscopic skills such as proper assembly of the hysteroscope and image optimisation. The setup also allowed trainees to practice manual dexterity skills necessary to negotiate the urethral canal. Despite the larger diameter of the resectoscope, trainees were able to negotiate it through the urethra easily. They then proceeded to inspect the entire bladder cavity and both the ureteric orifices. Resection of the bladder urothelium was performed with the resectoscope in the saline medium, with a setting of 180 W cutting and coagulation.

Trainees were also taught to use the flexible hysteroscope to perform the diagnostic procedure. Although the diameter was small, we did not encounter leakage of saline from the urethra during the study (Fig. 2).

Discussion

We describe 4 anatomical similarities between the pig bladder and human uterus that facilitate training of basic hysteroscopic skills (Table 1a). Apart from anatomical similarities, the realistic tissue resistance (tactile feel) and varied tissue conditions provided by this animal model are important components in hysteroscopy training.

Similarly, we describe 5 clinical scenarios (intraoperative difficulties) that can be simulated using this pig bladder hysteroscopy training model (Table 1b). These situations are often encountered while performing hysteroscopy on patients. In view of the common occurrence of these



Fig. 1. Photographs showing the set-up of the “uterine” model.

situations, it would be ideal for trainees to master techniques of avoiding or managing these scenarios before attempting hysteroscopic procedures on patients.

An Almost Anatomically Accurate Model
Why Do We Choose Pig Bladder?

The neck of the pig bladder and urethral anatomy reveal well defined, smooth and striated muscle layers which are similar to the human cervix and internal cervical os. The short narrow segment of the urethra is similar to the cervical canal. It was reported that circular smooth muscle developed maximally in the mid urethra of the pig, where the point maximal urethral pressure was observed.⁸ This anatomical arrangement effectively mimics the cervix with sphincter-like constrictive pressure, which we often encounter at the internal cervical os during hysteroscopic procedure. Thus, trainees were able to encounter dilatation at the bladder neck during saline insufflation and insertion of the scope (Fig. 3). In addition, we were able to teach

Table 1. Clinical Scenarios

Similar to the human uterus in the followings:	
Table 1a.	1. Passage through the urethra with sphincter-like dilation at the bladder neck is similar to the cervical canal.
	2. Folds of the urethral/bladder mucosa have similar appearance to endocervix/endometrium.
	3. Distensibility of the bladder cavity is similar to that of the endometrial cavity.
	4. Ureteric orifices mimic the tubal ostia.
Intra-operative difficulties simulated:	
Table 1b.	1. Obscuring of vision due to debris floatation and, charring or overhang of the tissue on the wire-loop.
	2. Resection of the urothelium is similar to that on the endometrium.
	3. Incomplete resection of the tissue and tissue stuck on the wire-loop.
	4. Saline bubbling during resection.
	5. Possible bladder perforation.



Fig. 2. Photograph on the left: Performing diagnostic hysteroscopy using the rigid hysteroscopy. Photograph on the right: Using the flexible hysteroscopy on the pig bladder "uterine" model.



Fig. 3. Photographs showing dilatation at the bladder neck, urothelial folds and ureteric orifices.

trainees the technique of negotiating the endocervical canal using water pressure to dilate the canal and keeping the “tunnel” at the centre of the screen. The tactile feel provided by the model created a realistic training model which was greatly appreciated by trainees.

Michael Swindle gave a detailed description of the anatomy of pig bladder in his book.⁹ Although he commented that pig bladder is generally large and thin-walled, this may be an advantage for hysteroscopic training as it allows room for manoeuvre and provides optimal vision. The muscular outer layer of pig bladder, coupled with an inner urothelial layer, makes it an ideal candidate for the uterine model.

The inner urothelial folds seen in pig bladder appear similar to the uterine folds we see in the human uterus. Both the ureters are located at the dorsolateral aspect of the pig bladder. The inner ureteric orifices mimic the ostia of fallopian tubes and their anatomical locations are almost similar to that of the fallopian tubes in the human uterus.

Consideration on the use of animal uterus such as pig, goat or cat had been taken. However, they are not suitable as most of them have bicornuate uterus as compared to the simplex uterus in the human. For example, in the case of the pig uterus, the smaller uterine body branches anteriorly into 2 large uterine horns.

Simulated Intraoperative Difficulties

The pig bladder training model facilitates instruction of skills in both diagnostic and therapeutic hysteroscopy, such as proper orientation and image optimisation of the scope. It also offers a realistic platform for performing hysteroscopic resection. This model allows trainees to practice manual dexterity skills necessary to negotiate the endocervical canal, orientation of the uterine cavity, visualisation of the ostia and resection of the endometrial tissue.¹⁰ In addition, it offers trainees simulated intraoperative difficulties for a more realistic surgical training.

Reproduction of “Difficult” Situations

Traditionally, realistic “difficult” human situations have been hard to reproduce using computer simulation or inanimate models. The need for tactile feel and appropriate tissue resistance in these situations are essential in the effective reproduction of these situations.

We describe 5 “difficult” situations that we are able to simulate for training purposes using this pig bladder hysteroscopy training model. These “difficult” situations are often encountered while performing hysteroscopy on human patients. Thus, it will be ideal for trainees to master techniques of avoiding or managing them before attempting hysteroscopic procedure on actual patients.

Obscuration of Vision due to Debris Floatation and, Charring or Overhang of the Tissue to the Wire Loop

Obtaining clear vision is a basic principle of any surgery. Blurred vision is often encountered during hysteroscopic procedure due to tissue debris or sheared tissues floating in saline after resection (Fig. 4). It is vital for trainees to learn how to flush out the debris by controlling the output channel. Often, we also encounter difficulty removing tissue stuck to the wire loop during resection.

Resection of the Urothelium is Similar to that on the Endometrium

Hysteroscopic resection using electrosurgery is a challenging task. The challenge exists because using electrosurgery carries risks that can be as minor as bleeding, or potentially as serious as causing perforation of the uterus. The stereotactic skills necessary to perform resection require practice and experience. Appropriate tissue resistance and tactile feel are essential conditions when performing hysteroscopic resection that can only be achieved with animal tissue models (Fig. 5).

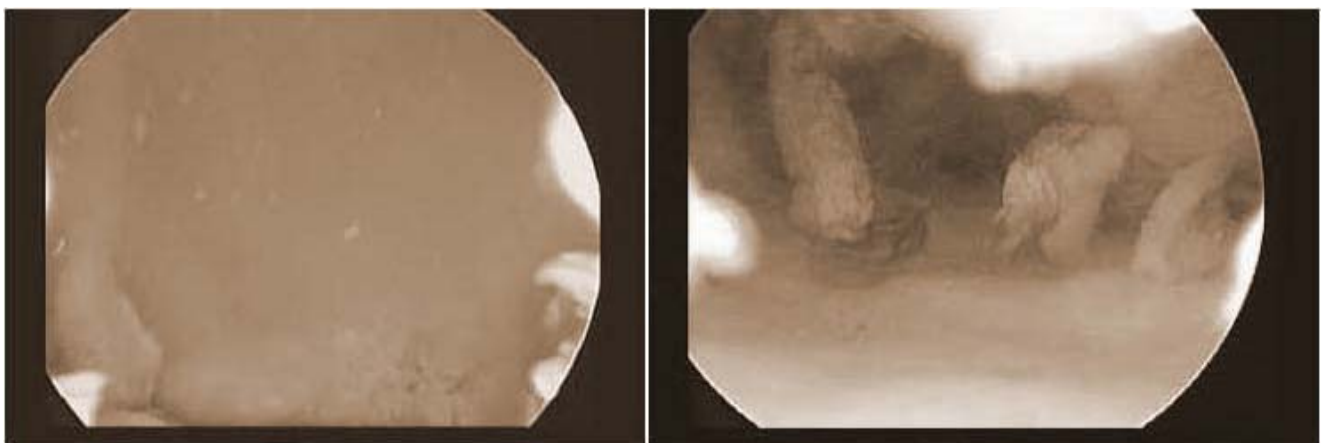


Fig. 4. Intraoperative difficulties: Photographs showing obscuration of vision due to debris; and sheared tissue floating within the uterine cavity.

Using this animal tissue model, trainees could experiment with shearing the urothelium using electrosurgery, without fear of causing bleeding or perforation. With the ability to perform multiple resections in rapid succession, trainees rapidly acquired and mastered the necessary manual dexterity skills to achieve a higher level of confidence in performing this procedure.

Incomplete Resection of the Tissue, Tissue Stuck at the Wire-Loop and Saline Bubbling during Resection

The addition of more complex obstacles simulated by this animal model can provide a wider range of experience for the trainees. Obstacles such as sheared tissues getting stuck to the wire-loop, partial resection of the endometrium and saline bubbling during resection give additional dimensions to the training experience (Fig. 6).

The animal model provides a unique platform to reproduce such obstacles. In addition, it provides the appropriate tissue resistance or “feel” to the trainee. The variable minor

changes encountered when using this “uterine” model give rise to a very realistic training situation. We use this model to train our trainees in troubleshooting and resolving these obstacles. For example, removing bubbles by placing the scope into the bubble and opening the outflow channel is a very useful manoeuvre. So far, no known existing computer simulation or inanimate training models have yet to be able to reproduce such obstacles.

Bladder Perforation

Last but not least, perforation of the uterus can be reproduced using this animal model (Fig. 7). Thus, it gives us an opportunity to teach trainees how to manage such situations in a non-fearful environment.

Future Research

This study focused on the design and construction of the “uterine” model, and included suggestion of 5 possible simulated situations for hysteroscopy training. There are

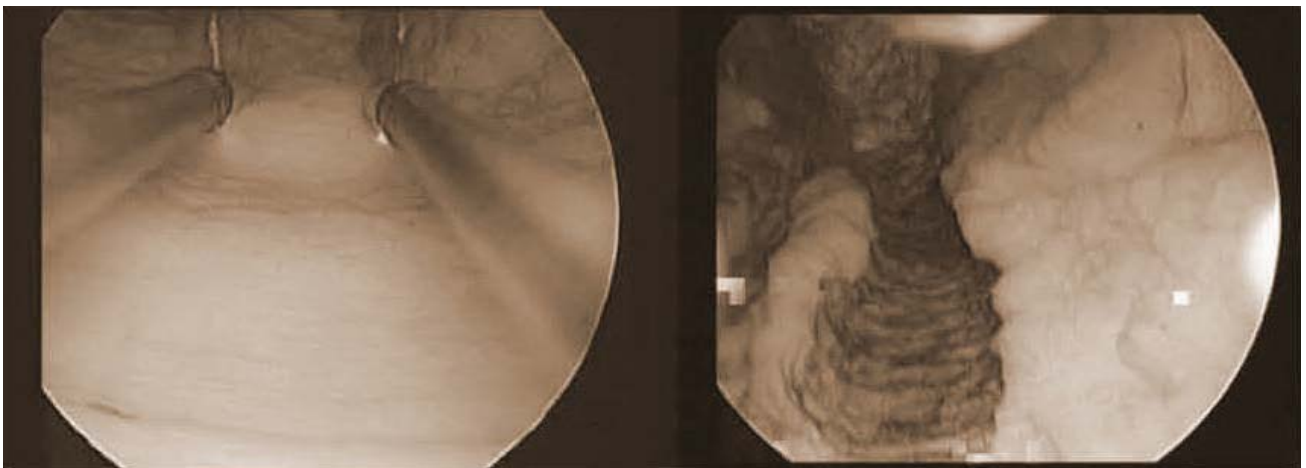


Fig. 5. Intraoperative difficulties: Photographs showing shearing of the urothelium using electrosurgery; and charring of the tissue during the procedure.

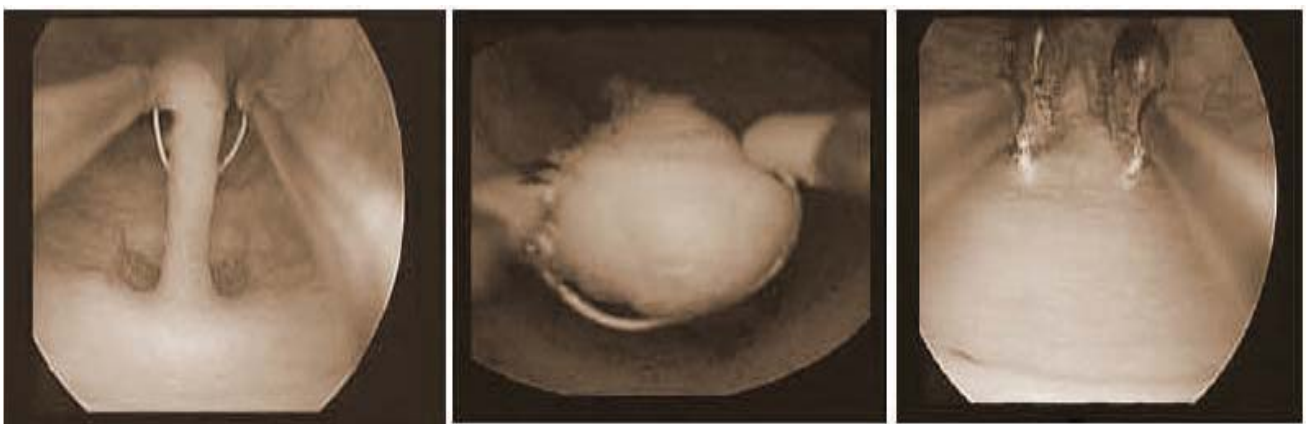


Fig. 6. Intraoperative difficulties: Photographs showing incomplete shearing of the tissue; small piece of tissue “stuck” at the wire-loop; and saline bubbling when using electrosurgery.



Fig. 7. A photograph showing perforation of the bladder.

however many potential extrapolation of this model using one's creativity. For example, one of the more common difficulties encountered by trainees is the inability to pass the hysteroscopy into the uterus or possibly a stenotic os. One may consider putting the "bladder" model in a box to eliminate visual feedback for the trainees. By arranging or securing the bladder in the box, the model may simulate anteversion and retroversion of the human uterus. Another suggestion is to use a rubber band or tension clips around the urethra, thereby simulating stenosis at the os.

This model may be further modified to include pathological situations. Some suggestions include banding of the model to simulate bicornuate uterus and suturing of meatballs onto the inner cavity of the uterus to simulate uterine polyps. Certainly, these suggestions will be employed in our next workshop so as to create a more comprehensive learning syllabus for the trainees.

Further study may also be conducted to obtain feedback from the trainees or gynaecologists, and to validate the usefulness of this model in the training of our young trainees.

Conclusion

The traditional system of apprenticeship learning is far from ideal. It presents risks to the patients when the least experienced surgeon performs such a critical procedure, especially when electrosurgery is required.¹¹ Although, in the last decade or so, computer simulation has been introduced into the training arena with the hope of leveraging some risks, it is still far from the real situations that we often encounter in cases with human patients.

This pig bladder "uterine" model, besides being low cost and easily available, adds new dimensions to the training experience by providing tactile feel and simulating intra-operative difficulties. We believe that this model is an excellent platform for hysteroscopy training, an important skill for any practicing gynaecologist.

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