Novel Inanimate Training Model for Urethrovesical Anastomosis in Laparoscopic Radical Prostatectomy

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OBJECTIVE: We developed a novel ex vivo training model for advanced laparoscopic suturing techniques necessary in laparoscopic radical prostatectomy (LRP).

METHODS: An inanimate model was developed to approximate real-life conditions in laparoscopic urethrovesical anastomosis. A segment of porcine ovarian tube inserted through a hard piece of cardboard (urethral stump) in a small open box and a part of pig stomach with a 2-cm hole (bladder neck) were placed in a specially designed setup in a traditional pelvic trainer, while the trocars were arranged in the usual five-port style during an LRP. The trainees practised suturing the “bladder neck” to the “urethral stump” with intermittent or continuous sutures according to their preferences.

RESULTS: The setup successfully mimicked the spatial relationships of the organs to be anastomosed during live surgery. The directions of the trocars and the angles of the instrumentations in the training model also imitated those during LRP. After practising on our models, the surgeons spent significantly less time (65 ± 24 min vs. 36 ± 12 min, \( p = 0.035 \)) performing actual urethrovesical anastomosis.

CONCLUSION: This inanimate laparoscopic suturing training model for urethrovesical anastomosis is a novel, effective, convenient and economic training tool, especially for beginners of LRP. [Asian J Surg 2010;33(4):188–92]

Key Words: laparoscopy, prostate cancer, radical prostatectomy, surgical anastomosis, training model

Introduction

After more than a decade of evolution in the urologic field, many ablative laparoscopic operations and a few reconstructive laparoscopic operations have become important alternatives to, or have even replaced, their traditional open counterparts.1–5 More cases of pyeloplasty for ureteropelvic junction obstruction1,2 and radical prostatectomy for localized prostate cancers3,4 are being performed using a laparoscopic approach in major medical centres throughout the world. The oncologic result of laparoscopic radical prostatectomy (LRP) is similar to its traditional open counterpart.5 The technical challenges of LRP include not only delicate anatomical excision of the prostate, but also reconstructive anastomosis of the urethral stump and bladder neck.3,4 For those surgeons who want to perform

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reconstructive laparoscopic surgery, it is of the utmost importance to master the technique of laparoscopic placement of intracorporeal sutures.

Traditional pelvic trainers for practising laparoscopic techniques are helpful for beginners of laparoscopic surgery. However, when surgeons move to higher levels of preclinical training, especially in reconstructive surgery, practising in a traditional pelvic trainer becomes less effective because actual conditions (locations and alignments of the target tissues for anastomosis, angles among the instruments, the scope, the targets, and other factors) of laparoscopic suturing during surgery are often completely different from those in the pelvic trainer.

To mitigate the gaps between the traditional ex vivo practice and the human in vivo scenario, we developed an inanimate model by using ex vivo porcine organs or tissues and arranged them in specific settings to more closely mimic the real-life conditions of urologic laparoscopic reconstructive surgery.

**Patients and methods**

A hard piece of cardboard with a hole in the middle (representing the pelvic floor) was obliquely placed in a one-sided open plastic box (10 cm³). This box was then attached to the en face side wall in a traditional pelvic trainer (Figures 1, 2A, and 2B). A short segment of a porcine ovarian tube purchased from a butcher store was inserted into the hole in the middle of the cardboard just exiting the cardboard for approximately 0.5–1 cm, representing the urethral stump (Figure 2B and 2C, white arrow). A part of the pig stomach with an open hole 1.5–2 cm in diameter was then placed obliquely in the dependent portion of the box near the cardboard to represent the bladder neck opening (Figure 2B and 2C, black arrow). The locations of the trocars were arranged in the usual five-port fashion during the laparoscopic radical prostatectomy depending on the preference of the surgeon. While practising using porcine tissues, a hard rod piercing through the walls of the pelvic trainer and the posterior wall of the 10 cm³ plastic box and inserted right into the lumen of the pig ovarian tube (urethral stump) could be used as a Benique urethral sound to guide the passage of the needle through the urethral stump. The trainees could practice suturing the “bladder neck” to the “urethral stump” with either intermittent or continuous sutures, according to their preferences (Figure 2D).

For the sake of simplicity, the porcine tissues used in this model were replaced with synthetic material at the beginning of practice. A piece of rubber tube approximately 0.7–1 cm in diameter was used as the urethral stump, while the palm part of a heavy rubber glove was used as the bladder. They were arranged in the same setup as described above.

The time spent for urethrovesical anastomosis in each case of LRP was recorded and compared for cases before and after intensive training in our specific training models. Data in this study are expressed as the mean ± standard error of the mean. Comparisons between groups were made by means of independent Student’s t tests. A p value of less than 0.05 was considered statistically significant.

**Results**

This novel ex vivo training setup effectively mimicked the spatial relationship of the organs to be anastomosed during the urethrovesical anastomosis part of the human LRP. The directions and the angles of the trocars, as well as the instruments and scope of the target organs, closely resembled those of actual surgical conditions. During actual surgery, the pelvic floor containing the urethral stump lies obliquely to the telescope, and the needle must make an en face and perpendicular penetration of the urethral stump. These important facts, which significantly influence the
The technical complexity of the procedures, are faithfully reflected in our model. During practice, the “bladder” was brought to the “urethral stump” with the sutures in an antigravity fashion. Two trainees worked together to adjust the position of the telescope for easier handling of the needle, for exact penetration of the tissues with the needle, and for intracorporeal knot-tying (Figure 2D).

Before practising in this special pelvic trainer, surgeons were either unable to execute this reconstruction or spent $65 \pm 24$ min ($n = 43$) to complete the urethrovaseal anastomosis during an LRP. After regular exercises (2–4 times per week, 30–60 min for each practice) with this model for 2–3 weeks, those who could not accomplish the anastomosis by themselves were able to perform this procedure smoothly, and the average time spent in the urethrovaseal anastomosis was significantly shortened to $36 \pm 12$ min ($n = 65, p = 0.035$). Further subgroup analysis, as shown in Table 1, revealed that the training model significantly improved the laparoscopic skill of urethrovaseal anastomosis and shortened the operation time.

**Discussion**

The use of traditional pelvic trainers for practising laparoscopic suturing, such as those designed since the time of Dr Kurt Semm, are helpful for beginners to learn and experience how to hold the instruments, how to adjust the needle, and how to drive it through the target intracorporeally. However, there are gaps between this initial *ex vivo* practice and the actual surgical conditions, and surgeons might feel frustrated when they move directly from the traditional training box to real-life scenarios because the
locations and directions of the target tissues to be anastomosed, as well as the alignments and the angles among the instruments, the scope, and the target tissues are often quite different from those in the training box. Moreover, in the pelvic trainer, people usually do not suture in certain specific directions or depths, which is often necessary during real reconstructive operations.

The design of our novel urethrovesical anastomosis model has several distinctive features. To accommodate the different axes of the needle and instruments because of the fixed pivotal effects of the laparoscopic trocars, holding the needle with the needle holder at different angles requires careful practice to ensure adequate and sharp penetrations of the tissues to be sutured. This concept is unique in laparoscopic suturing because, by convention, the needles were always held perpendicular to the needle holder and the operators simply adjusted their hands or wrists to gain good tissue bites during open surgery. Our novel model also closely mimicked the arrangements of organs to be anastomosed, as well as the positions of ports and scopes, which are placed almost exactly the same way as during the human operation. Once proficient in our novel inanimate trainer, surgeons will find it more comfortable to perform the surgery in their patients.

Because the prostate, which connects the urethra and the bladder, is removed during the ablative part of the radical prostatectomy, there is a space defect between the bladder neck and the urethral stump before the anastomosis. In addition, the bladder neck is in a more dependent position than the urethral stump because the patient is in a Trendelenburg position during an LRP and because the bladder is attached to its pedicles and surrounding tissues. During the initial few stitches of urethrovesical anastomosis, the bladder must be brought up to the urethral stump in an antigravity fashion to close the gap. In our model, this situation was well mimicked and could be correctly practised because we used part of a porcine stomach or a heavy glove to represent the urinary bladder. It was quite heavy and initially lied on the floor of the pelvic trainer. This configuration forced the trainees to exercise an antigravity technique to bring the “bladder” up to the “urethral stump” during practice. If the trainees failed to do so, there was a gap between the “urethral stump” and the “bladder” after completion of the suturing. The trainees could continue practising in this model until they were able to bring the two structures tightly together to ensure a watertight urethrovesical anastomosis during the live surgery. To the best of our knowledge, there has been no article in the literature addressing any training technique regarding this situation.

In our model, the small plastic box in which the cardboard resided was attached to the side wall of the trainer and simulated the limited space of the small deep pelvic cavity where the procedure actually takes place. Synthetic materials usually replace real tissues for practice in pelvic trainers, but in our model, the handling characteristics of the ex vivo tissues that were freshly purchased from the market did not differ much from the real in vivo tissues, with the exception of the absence of bleeding. All of these features make our novel model different from those using only rubber or plastic materials.

Although the group led by Abbou constructed a training model for laparoscopic urethrovesical running anastomosis with chicken skin and yielded good training results, our model further delicately improved the details of the training box by configuring it in a special spatial arrangement to approximate the small and oblique spaces of the human pelvic cavity. Hence, the trainees could adapt to the special angle of the structures to be anastomosed and learn to hold the special inclination of the needle for passing through the tissues to be sutured.

With advancements in computer and information technology, some forms of virtual reality simulators are being developed for training surgeons in a similar manner to that in which the army trains pilots in flight simulators.

<table>
<thead>
<tr>
<th>Laparoscopy surgical experience of trainee</th>
<th>Pretraining urethrovesical anastomosis time (min)</th>
<th>Posttraining time of urethrovesical anastomosis (min)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥5 yr</td>
<td>59 ± 18 min</td>
<td>32 ± 12</td>
<td>0.035</td>
</tr>
<tr>
<td>&lt;5 yr</td>
<td>74 ± 28 min</td>
<td>46 ± 23</td>
<td>0.043</td>
</tr>
<tr>
<td>p</td>
<td>0.037</td>
<td>0.044</td>
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</tbody>
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Table 1. Comparison of anastomosis time in different groups of surgeons
However, not many hospitals in developing countries can afford these new machines just for training. These machines also lack tactile feedback,\textsuperscript{9–11} which makes the training still somewhat different from real operation room scenarios. When compared with simulators, virtual reality machines,\textsuperscript{9–11} or live animal \textit{in vivo} exercises,\textsuperscript{14} our models are fairly inexpensive in terms of both materials and human resources. There is no need to buy a whole set of machines, have a live animal on which to work, or incur the expenses of having a live lab animal and hiring a veterinarian. It is also convenient to practise in our novel pelvic trainer model: no live animals, special spaces, specific sanitary conditions, respiratory machines, intravenous lines, or medications are needed. The setup of the model is easy and can be homemade by cutting cardboard into the desired size and shape. It can be used at any time and in any place.

Although there are increasing numbers of surgeons using medical robotics, which possess three-dimensional images and more degrees of freedom in the instruments and are designed to convert intuitive movements into correct laparoscopic actions to facilitate reconstructive laparoscopic surgery,\textsuperscript{15} these are quite expensive and not very affordable to the majority of hospitals. They also lack the tension feedback of instrumentation. Even those who usually work with robotics might experience unexpected out-of-order challenges with the system. Under such circumstances, if they have prior practice in our novel training model, instead of direct conversion to open surgery, they can easily convert a robotic-assisted procedure to the conventional laparoscopic procedure to bring the patients safely through the surgery.

In conclusion, this inanimate laparoscopic suturing training model for urethrovesical anastomosis is novel, effective, convenient, and economic. It is especially valuable for beginners of laparoscopic reconstructive surgery, those who do not have a heavy caseload, and those who cannot afford robotics or modern simulators.

\textbf{References}