Retention of robot-assisted surgical skills in urological surgeons acquired using Mimic dV-Trainer

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Abstract

Introduction: We assess the retention of robot-assisted surgical skills among urologic surgeons.
Methods: The robot-assisted surgery skills of 20 urologic surgeons were assessed using a Mimic dV-Trainer program (Mimic Technologies, Inc., Seattle, WA) consisting of 6 tasks. These 20 surgeons had no previous experience either using the Mimic dV-Trainer or acting as the main surgeon in robot-assisted surgery. The surgeons completed the program 4 times in a row; after 1 year, they completed it again for a fifth time. Performance scores were recorded using the Mimic dV-Trainer's built-in algorithm.
Results: For all 6 tasks, there were significant improvements to the scores in the fourth trials compared with those in the first trials. The scores in the fifth trials did not significantly decline compared with those in the fourth trials. There was no significant difference between the fifth trial scores of surgeons with laparoscopic surgery skills/experience and those without.
Conclusion: Our results indicate that fundamental robot-assisted surgical skills can be retained in the long-term after they are acquired.

Introduction

The use of robot-assisted surgery to treat urologic diseases has spread rapidly; this type of surgery is expected to overcome the technical difficulties presented by conventional laparoscopic surgery. Investigators have demonstrated the feasible learning curve of operative time, blood loss and margin status in robot-assisted surgery.[1-4] While novel surgical techniques have been developed, it is very important to clarify the acquisition and the retention of such techniques. We previously reported that the fundamental techniques of robot-assisted surgery could be mastered regardless of familiarity with laparoscopic surgery.[5] Now, to clarify the actual usefulness of learning the skills associated with robot-assisted surgery, it is essential to investigate not only the acquisition of the skills but also the rate of retention. Suh and colleagues reported that levels of retention improved after robot-assisted surgery training.[6] However, in that study, the participants were medical students and the observation period was short. A longer period of retention for surgeons should be investigated.

Virtual-reality simulator training has been shown to improve surgical performance in laparoscopic procedures in the operation room[7,8] and well-validated simulators have been used to study the learning process of many techniques in addition to surgical training. The Mimic dV-Trainer (MdVT, Mimic Technologies, Inc. Seattle, WA) is one of the highest-regarded virtual-reality simulators for the daVinci Surgical System.[9-11] MdVT scores are closely linked to robot-assisted surgery skills and are thus useful for helping urological students to learn the necessary skills.[12,13]

In this report, we discuss the retention of robot-assisted surgical skills acquired by urologic surgeons using a virtual-reality surgical trainer.

Methods

Participants

The group sizes were chosen in accordance with previous studies on virtual reality surgical simulations.[8-11] For this study, 20 urological surgeons were recruited from 4 different hospitals around Hiroshima City, Japan (Table 1). None had any experience with the dV-Trainer or were ever the main surgeon in a robot-assisted surgery. All participants provided written informed consent and were given guarantees of confidentiality.

Table 1. Demographics of participants (n = 20)	
Age (median)	33-52 (41)
Gender (male/female)	19/1
Years of urologic practice (median)	9-27 (17)
Experiences as head laparoscopic surgeon (cases) (median)	0-450 (70)

Simulator and tasks

The program in this study consisted of 2 needle-driving modules ("Suture Sponge" and "Thread the Rings") and 4 EndoWrist (Intuitive Surgical, Inc., Sunnyvale, CA) modules ("Pick and Place," "Peg Board," "Rope Walk," and "Energy Dissection," included in the MdVT as described previously).[5] Participants were given 2 to 3 minutes to develop familiarity with the platform and the task prior to starting the first trial. All participants completed the program 4 consecutive times, with intervals for several minutes and then a fifth trial was completed 1 year later (Fig. 1). Participants engaged in regular clinical work and had neither participated in robot-assisted surgery nor training with a simulator during the interval between the fourth and fifth trials. The scores of all participants were recorded and evaluated using the built-in MdVT algorithm. Scores between trials were compared to elucidate the improvement and/or retention of skills. To investigate the effect, if any, of prior experience with laparoscopic surgery, in the fifth trial we (1) compared the scores of participants who had been certified by the Endoscopic Surgical Skill Qualification System in Urologic Laparoscopic Surgery (ESSQSJJ)[14,15] with those who had not, and (2) compared the scores of participants who had functioned as the main surgeon in laparoscopic surgery 20 or more times with those who had not.

Statistical analysis

All statistical analyses were conducted using the JMP 10.0.0 (SAS Institute Inc., Cary, NC). Wilcoxon testing was used to assess the scores between each trial. P values of less than 0.05 were considered statistically significant.

Results

For all 6 tasks, there were significant improvements to the scores in the fourth trial compared with those in the first trial. The scores in the fifth trial did not significantly decline compared with those in the fourth trial, despite the absence of any robot-assisted surgery training for 1 year, and they were significantly better than those in the first trial for all tasks (Table 2, Fig. 2). There was no significant difference between the scores of certified and non-certified laparoscopic surgeons in the fifth trial (Table 3), and there was no significant difference between the scores of participants who had functioned as the main surgeon in laparoscopic surgery 20 or more times prior to initiation of this study compared with those who had not (Table 4).

Discussion

The results above demonstrate that fundamental robot-assisted surgery skills can be retained after they are acquired. To the best of our knowledge, this is the first report on the retention of robot-assisted surgical skills for urologic surgeons.

Urologic surgeons face a challenging task; they have to treat retroperitoneal organs in a limited space, while attempting to not only control the spread of cancer but also preserve bodily functions. Laparoscopic surgery has been useful, but the disadvantages include its technical difficulty and its longer learning curve. Robot-assisted surgery has overcome these problems. It enables more delicate techniques, of course, and now we expect that surgeons can master these techniques with a shorter learning curve.

Another advantage of robot-assisted surgery in terms of mastering the process is the retention of techniques after mastery. Several studies have been devoted to the retention of skills in areas, such as anesthesia, neonatology and obstetrics.[16-19] In laparoscopic surgery, a previous study using virtual-reality simulation demonstrated that although trainees retained their acquired skills for 6 to 7 months, after an additional 12 months with no training, their skills had reverted to the pre-training level.[20-22] Until now, the retention of robot-assisted surgical skills has not been reported. In this study, we focused on the retention of skills of robot-assisted surgery in Japanese urologic surgeons. Although robot-assisted surgery in Japan has recently begun and has already spread rapidly, our investigation of the process of mastering these techniques is both practical and relevant.

A significant point of the present study was that all subjects were urologic surgeons with no experience in robot-assisted surgery. Our findings suggest that the fundamental robot-assisted surgery skills acquired from our training tech-
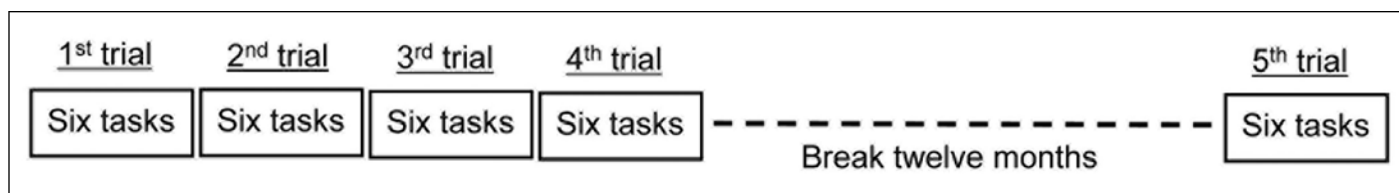
Fig. 1. Timetable for the trials.
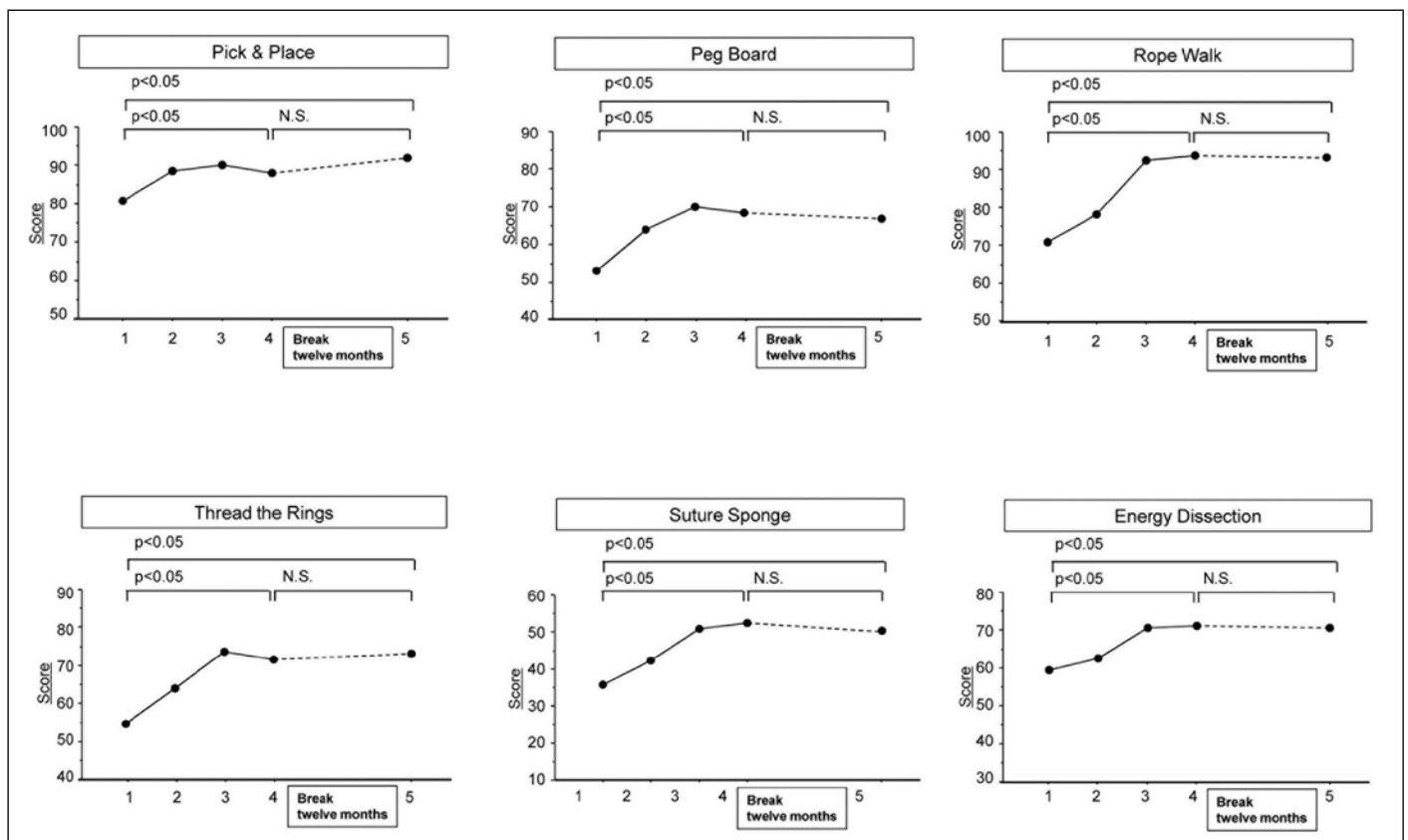
Table 2. Overall score of each task

	Pick and Place	Peg Board	Rope Walk	Thread the Rings	Suture Sponge	Energy Dissection
First trial	81.0 ± 10.3	52.7 ± 16.7	72.2 ± 11.6	55.6 ± 13.3	36.6 ± 9.8	60.6 ± 12.8
Second trial	88.8 ± 5.7	63.6 ± 14.7	79.6 ± 13.1	63.8 ± 10.9	43.7 ± 11.3	65.2 ± 17.5
Third trial	90.6 ± 6.9	69.9 ± 10.3	93.1 ± 7.9	71.6 ± 15.1	51.4 ± 16.1	70.6 ± 19.9
Fourth trial	88.6 ± 8.0	68.5 ± 14.7	93.8 ± 7.3	71.9 ± 14.8	53.1 ± 16.8	70.5 ± 9.4
Fifth trial (after interval)	92.3 ± 4.7	67.4 ± 9.9	93.7 ± 9.7	71.5 ± 13.1	50.9 ± 16.3	71.1 ± 14.9
p value (first vs. fourth trial)	0.0002	0.0036	0.0001	0.0004	0.0012	0.0228
p value (fourth vs. fifth trial)	0.0400	0.6542	0.4074	0.4553	0.3981	0.7938
p value (first vs. fifth trial)	<0.0001	0.0028	0.0003	0.0019	0.0025	0.0051

Mean ± standard deviation in each score.

nique can be maintained in the long-term as individuals go about their daily clinical tasks without additional training. In other words, it should be possible for clinical urologists to learn robot-assisted surgery skills fairly quickly and then retain these skills for a long time.

Many urologic surgeons who lack experience with laparoscopic surgery are expected to start performing robot-assisted surgery, so it is essential to investigate the impact of laparoscopic surgery experience (or lack thereof) in terms of not

only skill acquisition but retention. The ESSQSJJ,[14,15] a testing system moderated by the Japanese Society of Endourology (JSE) and the Japanese Urological Association (JUA), is a well-validated method of ensuring that surgeons can perform urologic laparoscopic surgery as chief surgeon with a low prevalence of perioperative complications and with reasonable outcomes.[15] We have previously demonstrated that the scores for all tasks in MdVT similarly improved after 4 completions regardless of familiarity with laparoscopic

Fig. 2. Mean total score of each of the tasks in the first to fifth trials for all participants. NS: not significant.

Table 3. Comparison of overall score in 5th trial between certified/non-certified laparoscopic surgeons

	Certified (n=7)	Non-certified (n=13)	p value
Pick and Place	92.5 ± 15.8	92.2 ± 27.3	0.9054
Peg Board	69.8 ± 11.8	66.1 ± 9.0	0.2505
Rope Walk	92.7 ± 12.6	94.3 ± 8.3	0.9684
Thread the Rings	77.1 ± 12.4	68.6 ± 13.0	0.2505
Suture Sponge	54.8 ± 20.7	48.7 ± 13.9	0.3219
Energy Dissection	70.3 ± 18.8	71.6 ± 13.2	0.9054

Table 4. Relationship between overall score in fifth trial and amount of laparoscopic surgery experience

Laparoscopic surgery experience	20 cases or more (n=9)	Less than 20 cases (n=11)	p value
Pick and Place	93.1 ± 3.6	91.7 ± 5.6	0.4704
Peg Board	67.7 ± 11.0	67.1 ± 9.5	0.8494
Rope Walk	94.3 ± 11.4	93.2 ± 8.7	0.3619
Thread the Rings	77.5 ± 12.1	66.7 ± 12.3	0.1024
Suture Sponge	54.9 ± 20.2	47.6 ± 12.4	0.3051
Energy Dissection	70.3 ± 19.5	71.8 ± 10.7	0.9697

surgery.[5] Thus, in the present study, to investigate the impact of laparoscopic surgery experience on the retention of robot-assisted surgery skill, we compared the scores of a fifth trial completed after 1 year between certified and non-certified surgeons, as well as between those who had experience with a certain number of laparoscopic surgeries. This score comparison showed that robot-assisted surgical skills were retained regardless of experience or certification (Table 3, Table 4). Combined with the results of our previous report,[5] our current findings suggest that robot-assisted surgery might be suitable for urologists without training or experience with laparoscopic surgery.

There were some limitations in this study. For example, the size was small, and the results were obtained from surgical simulations using MdVT rather than from actual robot-assisted surgeries. Moreover, since we focused on the retention of fundamental techniques, we evaluated only the easiest tasks in the MdVT, so it is possible that different results might occur with more difficult tasks. Although MdVT scores represent familiarity with actual robot-assisted surgery techniques based on previous studies,[8-13] further investigation is required to see if the results in the present study can be reproduced in actual surgeries and to study the retention of more advanced skills.

Conclusion

We demonstrated the long-term retention of robot-assisted surgical skills in urologic surgeons. Robot-assisted surgery is poised to become widespread in the near future, and our data highlight that even laparoscopically-naïve surgeons can learn and retain basic tasks on a robotic simulator. The present data indicate that urologic surgeons might be able to retain their skills in the long-term.

This paper has been peer-reviewed.

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