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A Modular Laparoscopic Training Program for Pediatric Surgeons

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ABSTRACT

Objectives: A structured endoscopic training program for pediatric surgeons has not yet been established. This study was conducted to develop a modular training program (MTP) for pediatric surgeons and to evaluate its effectiveness for surgeons with and without previous experience in laparoscopic surgery.

Methods: Nine pediatric surgeons participated in the study. They were divided into 2 groups: group A (n=4), surgeons who had experienced more than 10 cases of laparoscopic surgery prior to MTP; group B (n=5), those who had experienced fewer than 10 cases. They participated in a standardized MTP workshop, which consisted of 2 "see-through" and 3 "laparoscopic" tasks. Each participant's psychomotor skills were evaluated objectively before and after MTP with a computer-generated virtual simulator and were evaluated for precision, efficiency, and speed.

Results: In participants, speed was significantly enhanced after MTP. In group A, no differences were observed after MTP, whereas significant improvements were noted in efficiency and speed after MTP in group B. Before MTP, efficiency was significantly higher in group A than in group B; however, no difference remained between the 2 groups after MTP.

Conclusions: MTP is effective for nonlaparoscopic pediatric surgeons to become familiar with basic endoscopic skills.

Key Words: Laparoscopy, Training, Psychomotor skill, Pediatric surgeon.

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INTRODUCTION

Little dispute exists that special training is essential for pediatric surgeons before starting endoscopic surgery in children;[1] however, a structured and readily available training program for them has not been established.[2] We developed a basic modular training program (MTP), specially designed for pediatric surgeons. The aim of this study was to investigate whether our current MTP is effective for pediatric surgeons and whether their previous laparoscopic experience affects the training results.

MATERIALS AND METHODS

MTP participants

Nine surgeons who participated in MTP (7 males, 2 females, mean age 36.8±5.8 years, range 30 to 45 years) were assigned to this study. They were qualified by the Japanese Surgical Society after 4 years of residency in general surgery, and they had been in pediatric surgery practice for 1 to 15 years (mean 7.3 years). They were divided into 2 groups according to their clinical experience in laparoscopic surgery prior to MTP: group A (n=4), surgeons who had experienced more than 10 cases of laparoscopic surgery; group B (n=5), those who had experienced fewer than 10 cases. Because surgeons in group B had completed their surgical residency before the "laparoscopic era," their age and postgraduate years were significantly higher than those of surgeons in group A **(Table 1)**. No participants had taken skills development courses prior to MTP.

Each surgeon participated in the standardized 3-hour-MTP workshop, which consisted of an introductory video, a didactic session about instrumentation, and 2 "see-through" and 3 "laparoscopic" tasks.

See-through tasks were done as follows in an original training box made of acrylic acid resin, which mimicked the small abdomen of pediatric patients:

Peg Transferring

With the use of 2 pegboards and 10 pegs, each examinee was required to lift each peg from 1 pegboard with the left hand, transfer it to the right hand, and place it on

Table 1.
Profile of Modular Training Program Participants

	Group A	Group B	*P*
n	4	5	
Male/Female	2/2	5/0	
Age (years)	31.5±1.3*	41.0±4.0*	0.0028
Postgraduate years	5.8±1.7*	15±3.2*	0.0012

*Mean±SD.

the other pegboard **(Figure 1A)**. This was then reversed. The main aim was to make the operator familiar with the unique endoscopic instruments.

Pattern Cutting

This task involved cutting a 6-cm diameter circular pattern out of a 10 x 10-cm piece of white paper placed in the box **(Figure 1B)**. The task was repeated twice with each hand in turn. The aim was to use the grasper in 1 hand, placing the material under tension while cutting with the endoscopic scissors in the other hand.

After completing the see-through tasks, the participants then proceeded to the laparoscopic session. The tasks were done in a laparoscopic training box (Laparo Trainer®, Nippon Stryker, Japan) covered by an opaque membrane **(Figure 1C)**. Two 12-mm trocars were placed through the membrane at convenient working angles on either side of a 10-mm zero-degree rigid scope, which was mounted on a stand at a fixed focal length.

The following 3 tasks were done laparoscopically by displaying the modules on a high-resolution video monitor (VT-21G1, Sharp, Japan) placed in line with the operator.

Peg Transferring

The examinee was required to perform the peg transferring in the same way as in the see-through session. The aim was to get eye-hand coordination and ambidexterity under laparoscopic visual control.

Clip Application

This task involved placing 3 hemostatic clips on a tubular foam structure with appropriate margins and then cutting halfway between the clips. The purpose was to replicate the procedures similar to those encountered during operation.

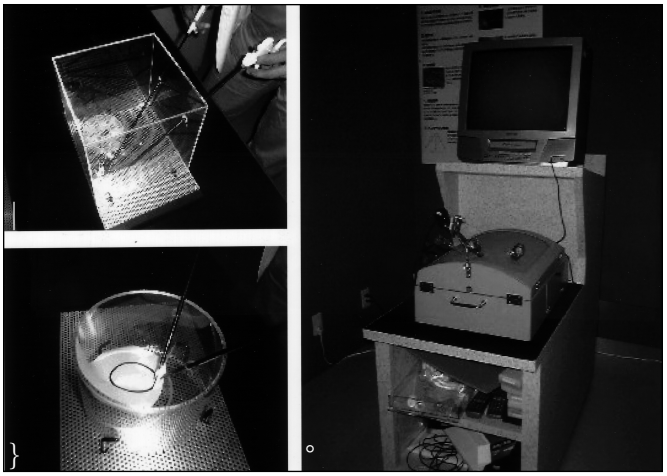

Figure 1. Modular training units: A. Peg transferring task in "see-through" module; B. Pattern cutting task in "see-through" module; C. Laparoscopic training box, LaparoTrainer®, with built-in light source, trocars, scope, and videomonitor in place.

Wire Twisting

Each operator was required to twist the metal wire placed through a sucking disc with 2 hands. This task was designed to develop the right and left hand coordination that is necessary for manual knot tying.

Evaluation of Psychomotor Skills

Each participant's performance was objectively evaluated before and after MTP with the computer-generated virtual simulator (MIST VR®, Virtual Presence Inc., UK), which has recently been reported as a confidential tool for objective assessment of psychomotor skills in laparoscopic surgery **(Figure 2A)**.[3] Participants were required to perform a simple virtual task that involved picking up a virtual ball, placing it in a virtual box, and then releasing it **(Figures 2B, 2C, 2D)**. The examinee repeated the task 4 times using each hand in turn. Path lengths, path velocities and distances to target profiles were recorded, and the following 3 scores were obtained: (1) a number of mispointing target balls (as an indicator of movement precision); (2) an actual/ideal path length ratio of the movements (as movement efficiency); (3) a time taken to complete the virtual task (as speed). The path ratio alone was processed for dominant and nondominant hands, respectively.

The data were analyzed with the Student paired *t* test to

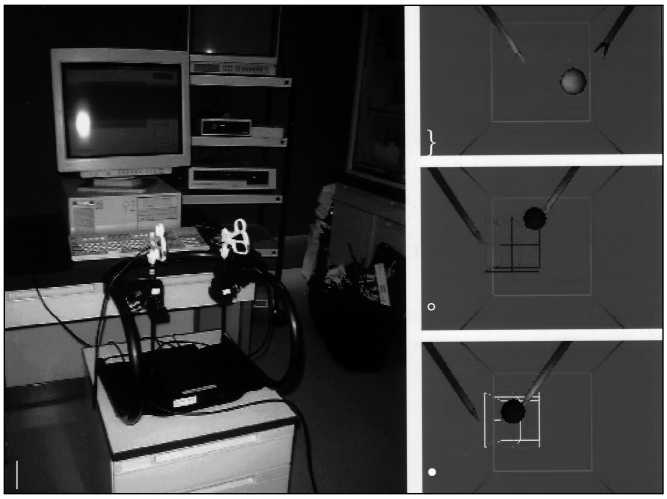

Figure 2. Computer-generated virtual simulator, MIST VR®: A. Whole view of system with interface; B. Starting task by picking up a virtual ball on PC screen; C. Transferring the ball into a box; D. Terminating task by releasing the target.

test differences in performance between before and after MTP and the unpaired t test between groups A and B. A value of $P<0.05$ was considered statistically significant.

RESULTS

Performance of Overall Participants

Table 2 summarizes the training results of overall participants. The time taken to complete tasks was significantly decreased after MTP, indicating the increased speed with which the participants handled the virtual tasks. No significant differences occurred in the number of mispointings and the actual/ideal path ratio of both dominant and nondominant hands before and after MTP.

Performance of Each Group

Table 3 shows the changes of performance before and after MTP in each group and the comparison of performance between 2 groups at each time point.

In group A, no significant differences occurred in the number of mispointings, the path ratio and the time before and after MTP. In group B, however, the path ratio of dominant hands was significantly decreased after MTP, indicating the significantly higher movement efficiency. The time was also decreased significantly after MTP, indicating the increased speed in this group.

Table 2.
Participants' Overall Performance

	Before*	After*	*P*
No. of mispointings	0.7±0.4	0.8±0.5	0.468
Actual/ideal path ratio			
Dominant hand	4.7±2.0	3.8±1.3	0.067
Nondominant hand	4.1±2.3	3.5±0.9	0.552
Time taken (secs.)	26.0±10.1	15.2±4.72	0.005

*Mean±SD.

Before MTP, the path ratio of dominant hands was significantly higher in group B than in group A, indicating the significantly lower movement efficiency in group B. After MTP, a significant difference no longer existed in the path ratio between the 2 groups.

DISCUSSION

Despite the wide acceptance of laparoscopic surgery among general surgeons, most pediatric surgeons remain unconvinced that laparoscopic surgery can be a valuable modality for pediatric surgical disorders.[4-6] The major reasons are the lack of proven long-term benefits, the question of increased complication rates, the longer operating time and the higher cost of equipment.[4,6] Another reason is that only a few pediatric surgeons have the opportunity to obtain endoscopic skills adequately and appropriately.[2]

The most natural place to learn surgical skills is in the operating theater; however, it is becoming increasingly difficult for present and future surgeons to acquire all surgical skills in the operating room, largely because of concern about safety, time, and cost.[2] It is therefore considered essential to establish a structured endoscopic training program outside the operating rooms, but to our knowledge, no previous study has been conducted regarding the development of such training courses for pediatric surgeons.

Our current MTP regimen includes 5 standard training tasks, 2 of which were done under 3-dimensional visualization in an original, transparent training box. The box has 15- to 20-cm widths and 10- to 20-cm depths, simu-

Table 3.
Performance of Each Group

	Group A (n=4)		Group B (n=5)	
	Before*	After*	Before*	After*
No. of mispointings	0.3±0.4	0.4±0.5	0.9±0.6	1.1±0.4
Actual/ideal path ratio				
Dominant hand	2.8±1.1	3.0±0.7	6.2±0.6†	4.4±1.3‡
Nondominant hand	4.9±3.6	3.1±1.2	3.5±0.3	3.9±0.6
Time taken (seconds)	23.3±10.0	13.4±2.5	28.2±10.8	16.7±5.8‡

*Mean±SD.
†$P < 0.05$ vs before modular training program in group A.
‡$P < 0.05$ vs before modular training program in group B.

lating the insufflated abdomen of infants. Two small holes drilled on the surface of the box mimic the surgical ports; thus, each trainee can realize the actual feeling of the fulcrum effect. Through repeated simple tasks, participants can gradually feel familiar with the unique action of delicate and long-handled endoscopic instruments. The remaining 3 tasks were done under 2-dimensional visualization. These tasks facilitate the fundamentals of unique perspective and spatial interface of endoscopic surgery. The participants could complete these 5 modules step by step at their own pace, being mentored by experienced endoscopic instructors.

Our MTP did improve the psychomotor skills of pediatric surgeons who had been less exposed to laparoscopic surgery. Their movement efficiency and speed were significantly improved after MTP, indicating the validity of our current curriculum. On the contrary, surgeons who had already been exposed to laparoscopic surgery could not gain further development of their skills through MTP. These results suggest that our current basic program is effective for initiating the nonlaparoscopic pediatric surgeons, but is not entirely satisfactory for laparoscopic surgeons.

It has been a commonly held assumption that younger surgeons have a natural advantage in the development of laparoscopic skills.[1] Our present study showed, however, that age did not appear to play a dominant role in the outcome. Senior pediatric surgeons who completed MTP could maintain their initial enthusiasm by being convinced that "it is not too late."

MTP had no effect on improving movement precision. This is partly because our MTP did not have proper modules to develop precise motion. Another explanation is that it may take more time to learn precise motion than effective and speedy motion. Further modifications are necessary to make MTP more effective in allowing surgeons to learn delicate, not merely quick motion, which seems more essential in clinical settings of pediatric laparoscopic surgery.

CONCLUSIONS

Our training program was effective for pediatric surgeons who have less experience in clinical laparoscopic surgery. A simple, nontime-consuming, and inexpensive training course is an attractive method for nonlaparoscopic pediatric surgeons to obtain basic endoscopic skills and to overcome their mental reservations.

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