Construct of Learning Model for Laparoscopic Surgery

Kazuaki Yamashiro[1(✉)], Akihiko Goto[2], Hisanori Shiomi[3], and Koichiro Murakami[4]

[1] Kyoto Institute of Technology,
Goshokaido-cho Matsugasaki Sakyo-ku, Kyoto, Japan
k.yamashiro546@gmail.com
[2] Osaka Sangyo University, Daito-shi, Osaka, Japan
[3] Nagahama Red Cross Hospital,
14-7 Miyamae-cho, Nagahama-shi, Shiga, Japan
[4] Tesseikai Neurosurgical Hospital,
28-1 Nakanohomma-chi, Shijonawate, Osaka, Japan

Abstract. Laparoscopic surgery is one of surgery method. It requires many experiences to acquire the techniques and time to educate others because, for example, it has little information that the operator can acquire through field of view and sense of touch, and need to get used to through the operation of forceps. Laparoscopic surgery have four learning method (Dry box, Wet lab, Simulator, animal lab). With the simulator, learnings are that immersed in the most realistic skills, training environment, gave the opportunity to develop proficiency in laparoscopic surgical techniques, provided accurate tactile, feel of need procedures and complications and gave risk–free learning before touching their first patient. However, it is impossible to train according to personal skills only simulator. Previous studies have shown that the surgeon' gaze point revealed when using the surgery simulator, thereby indicating that the result of the eye movement is useful for learning. The goal of this study is construction of learning system that to feedback the evaluation result to the learner. We analyzed the medical students' eye movements, there were individual differences in the medical students' gazing points, and there was a pattern in the medical students' gazing points. We were able to cluster them and divide them into groups.

Keywords: Eye movement · Laparoscopic surgery · Guidance

1 Introduction

Laparoscopic surgery is modern surgical technique in which operations are performed far from their location through small incisions (usually 5–15 mm) elsewhere in the body using laparoscope. It has some Characteristics compared the open procedure.

1. Specific surgical instruments are used include laparoscope forceps, scissors, probes, dissectors, hooks, retractors, and more.
2. Pain and hemorrhaging are reduced due to smaller incisions.
3. Recovery times are shorter than open procedure.

© Springer International Publishing AG, part of Springer Nature 2018
V. G. Duffy (Ed.): DHM 2018, LNCS 10917, pp. 558–566, 2018.
https://doi.org/10.1007/978-3-319-91397-1_45

In this way, Laparoscopic surgery will reduces the Patient's burden. However, this surgery demand some hard work on surgeon. For example, the restricted vision, the difficulty in handling of the instruments, the limited working area are the factors which add to the technical complexity of this surgical approach and additional training is necessary after completing their basic surgical skill. Therefore, Laparoscopic surgery has problems that require long time to get skills.

Learning method of Laparoscopic surgery are Dry box, Wet lab, Simulator and Animal lab. With the simulator, learnings are that immersed in the most realistic skills, training environment, gave the opportunity to develop proficiency in laparoscopic surgical techniques, provided accurate tactile, feel of need procedures and compli-cations and gave risk–free learning before touching their first patient. However, it is impossible to train according to personal skills only simulator.

In previous studies, we analyzed surgeons' eye movement in simulator of laparoscopic surgery and clarified that gaze point under surgery is stabilized as experience becomes longer. We thought that elucidation of eye movement in Laparoscopic surgery was useful to get skills. The goal of study is to construct system that feeds back the evaluation results to learners. This time, we do experiments for medical students and show the relationship between the medical students' eye movement and the contents of teaching done to medical students and the evaluation of simulator.

2 Experiment

2.1 Participants

Participants was 36 medical students who used the simulator for the first time, and the advising doctors was 2 surgeons with similar experience. Medical student divide into 7 groups. Table 1 indicates the number of medical students in each group and their advising doctors.

Table 1. Group breakdown

Group Number	Advising doctors	Medical student
G1	A	5
G2	B	6
G3	A	6
G4	B	4
G5	A	5
G6	B	4
G7	A	6

2.2 Measuring Device

Measuring device were employed a surgery training simulator LapVR (Gadelius Medical K.K.) and Calibration free gaze measurement EMR ACTUS (nac Image Technology Inc.). The detection rate was 60 Hz.

2.3 Experiment Method

In the experiment, we measured eye movements during practical training of laparoscopic cholecystectomy using a simulator. The experiment was done twice. The 1st experiment was the surgeon performed laparoscopic cholecystectomy in front of medical students as an experiment, and then medical students conduct the same surgery with guidance by him. The 2nd experiment was medical students perform the same case without any guidance. Figure 1 indicates how medical students are practicing.

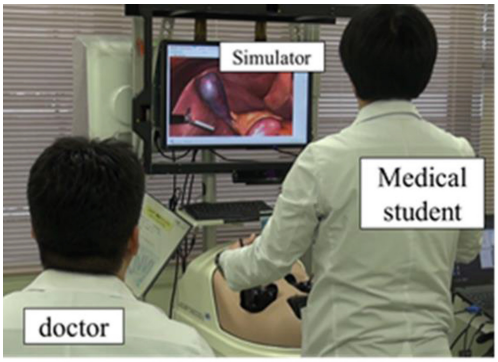

Fig. 1. Appearance of training

3 Analysis Method

3.1 Eye Movement

The eye movement data measured by the experiment was analyzed by Area of Interest (AOI). Figure 2 indicates examples of AOI range. This time, we clarified the gaze time ratio of the gallbladder to be worked.

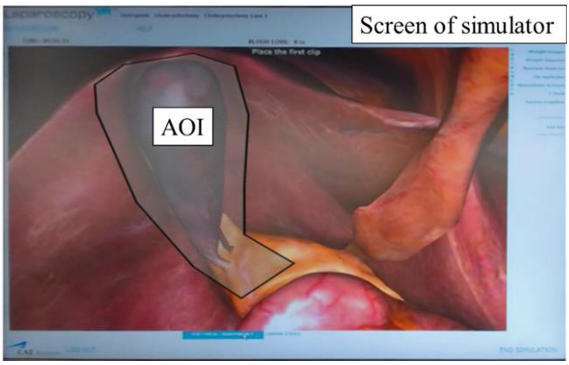

Fig. 2. Examples of AOI range

3.2 Evaluation of Simulation

It is evaluated that the work is completed by LapVR. We focused on the evaluation items "Actual result for Left. Path. Length" and "Actual result for Right. Path. Length". They are items directly related to the operation of the forceps and are easy to evaluate as numerical data.

3.3 Guidance Content

In the 1st experiment the advising doctors instructed medical students. The guide content was analyzed by SPSS Text Analytics for Surveys. We extracted specific words and counted those words into categories. Table 2 indicates category content. We revealed the guidance received by medical students by category.

Table 2. Category content

Category	Notation
Organ	A
Organ + Operation	B
Organ + Direction	C
Organ + Operation + Direction	D
Forceps	E
Forceps + Operation	F
Forceps + Direction	G
Forceps + Operation + Direction	H
Operation	I
Operation + Direction	J
Operation + Organ + Forceps	K

4 Result

4.1 Result of Eye Movement

It is important to keep watching the gallbladder during work. We calculated the ratio from the gaze ratio of the 1stexperiment and the 2nd experiment gall bladders and clarified the trend. Figure 3 indicates the increase or decrease of gaze ratios of each group. A positive value indicates that medical students are gazing at the gallbladder more than the 1st experiment, and a negative value indicates that medical students are gazing at the gallbladder less than the 1st experiment. For that reason, a positive value is said to be improving. In G1, the gaze ratio increased by 2 medical students. In G2, the gaze ratio increased by 4 medical students. Here was no medical student whose gaze ratio increased in G3. In G4, the gaze ratio increased by 3 medical students. In G5,

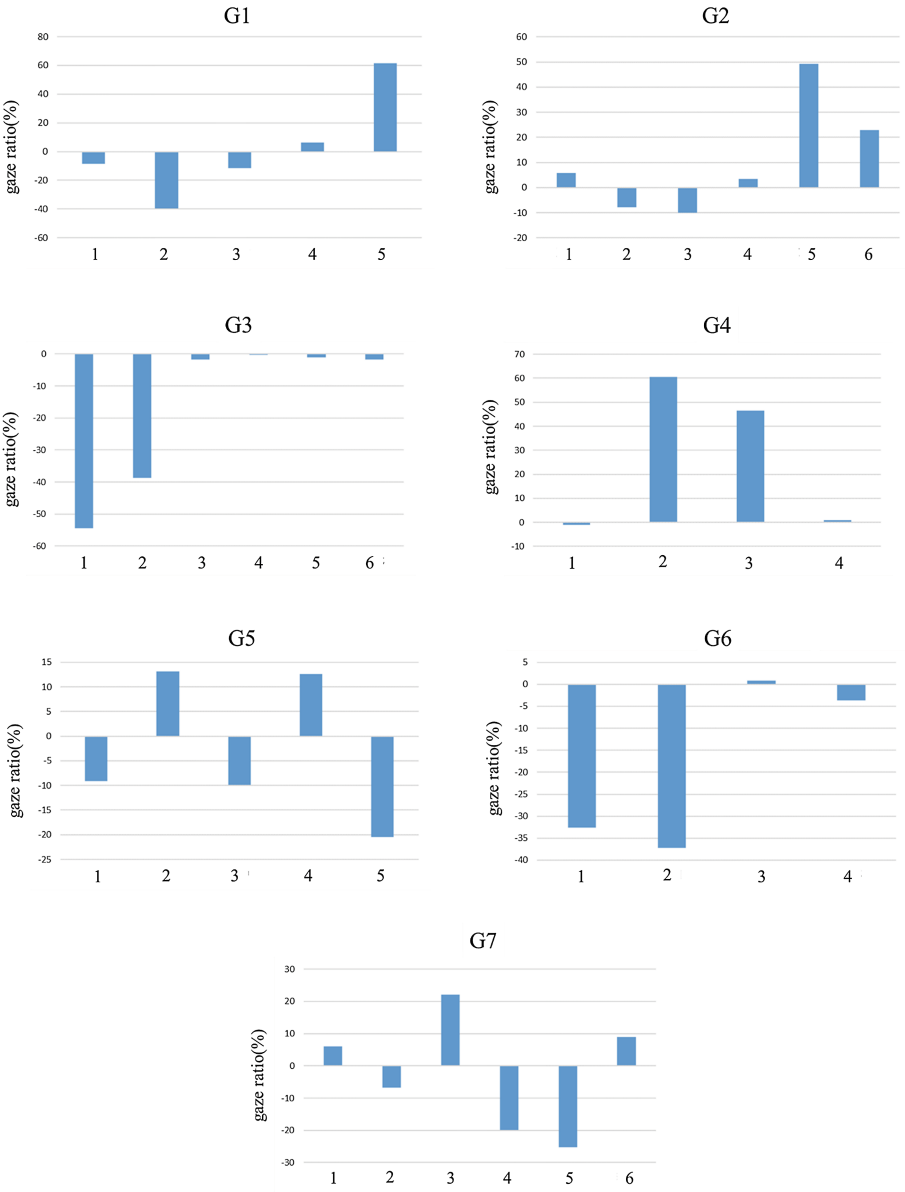

Fig. 3. Gaze ratios of each group

the gaze ratio increased by 2 medical students. In G6, the gaze ratio increased by 1 people. In G7, the gaze ratio increased by 3 medical students. 15 medical students as a whole had an improvement trend. There was also a medical student with an improvement tendency in each group except G3, and there was no group with all medical students tending to improve.

4.2 Evaluation of Simulator

The shorter the moving distance of the forceps, the more unnecessary work is being done. As with eye movements, we clarify the increase or decrease from the 1st experiment and the 2nd experiment results. Figure 4 indicates the increase or decrease

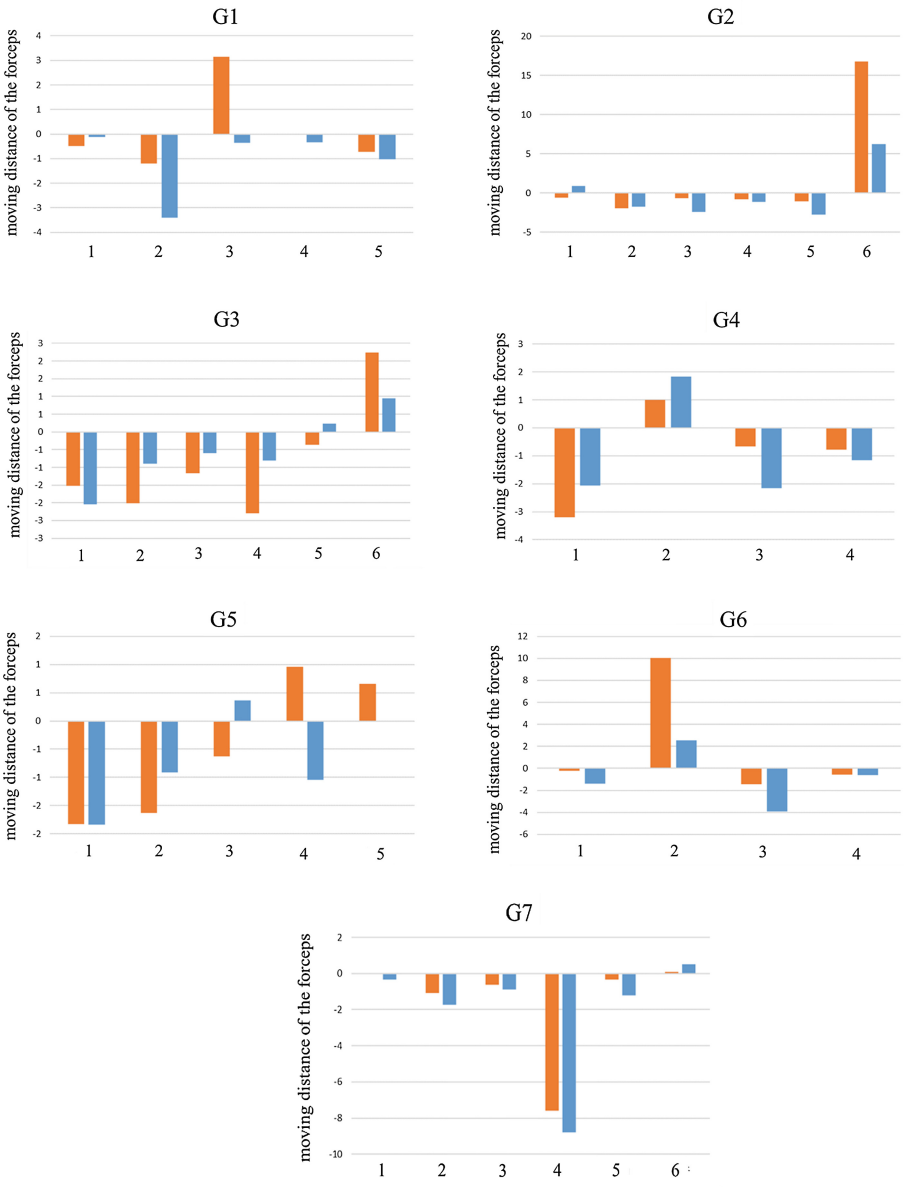

Fig. 4. Movement distance of forceps in each group

of the moving distance of the forceps of each group. A positive value indicates that the moving distance of the 2nd experiment is longer than that of the 1st experiment. A negative value indicates that the 2nd experiment moving distance is shorter than the 1st experiment. Therefore, a negative values can be said to be improving. In G1 as a whole there was an improvement trend, with only one left trending upward. In G 2, G 3 and G 4, only 1 medical student was not improving. In G5, there was an improvement trend in 2 medical student, there was 1 medical student with improvement tendency only on the left hand, and 1 medical student with improvement tendency only on the right hand. In the G6, there was a tendency for improvement to 3 medical student. In G 7, there was a tendency to improve in 4 medical student.

4.3 Guidance Content

Figure 5 indicates the proportion of remarks when teaching at the time of demonstration and guidance to medical students. In G1, G2, G3, G4, G5, the most "I" remark was made both for demonstration and guidance to medical students. In the G6, "E" was given at the time of demonstration and "I" was guided most guidance to medical students. In the G7, "A" and "E" was given at the time of demonstration and "I" was guided most guidance to medical students. Overall "I" remarks were made well. Also, there was a remark that became instructed after guidance to medical students.

5 Discussion

From the results of the eye movements and the results of the evaluation of the simulator, we thought that it is easy to get used to the operation of the forceps than to gaze the gallbladder. Because the number of medical students accustomed to operation of the forceps was larger than the number of medical students who can gaze at the gall bladder. From this, medical students can be divided into categories for each proficiency level. From the results of the guidance contents, the explanation of the operation has been increased, and as guidance to medical students guides the operation in more detail. We think that there are many medical students who improved the operation of forceps by guidance. It is necessary to investigate whether gaze improvement is further made by teaching gaze points as guidance.

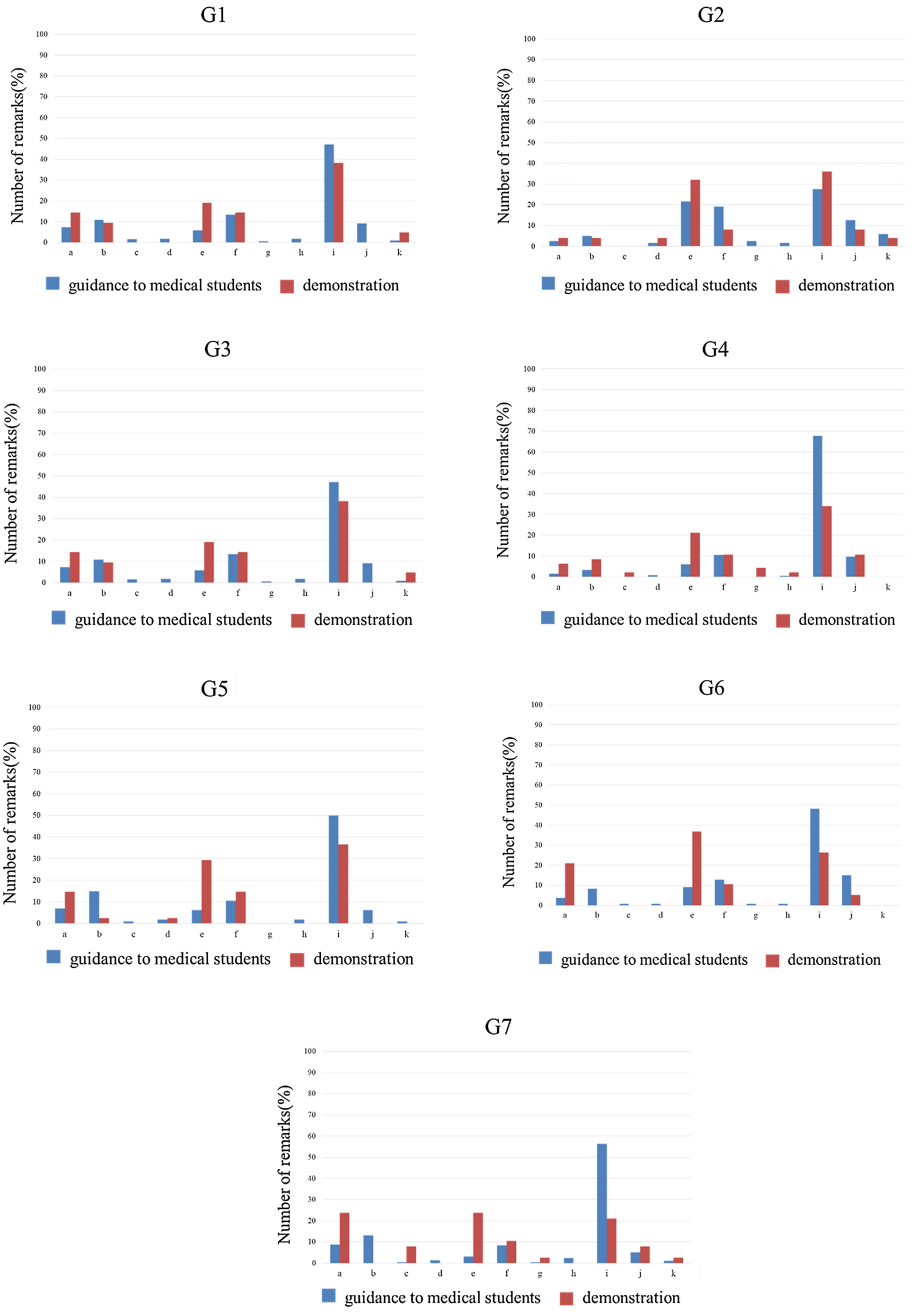

Fig. 5. Number of remarks at the time of demonstration and guidance to medical students

6 Conclusion

This study revealed the characteristics of medical students. We propose feedback method by evaluation given to learners. For example, we give scores on the result of eye movements and evaluation of the simulator, and make it possible to confirm our own skill level by score. The learners can receives the necessary training according to the score. This will allow learning more suitable for individuals.