



# The impact of preclinical clerkship in general surgery on medical students' attitude to a surgical career

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Received: 17 August 2022 / Accepted: 9 November 2022 / Published online: 3 December 2022  
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## Abstract

**Purpose** With the advent of a new program for postgraduate medical students in 2004, the number of applicants choosing surgical careers in Japan has been declining. We conducted this study to evaluate the impact of preclinical clerkship and how it affects students' attitudes toward a surgical career.

**Methods** The subjects of our study were fifth-year medical students who participated in a clinical clerkship in general surgery in our department between April 2021 and March 2022. We conducted pre- and post-preclinical clerkship surveys to assess the perceived image of surgeons and the impact of clerkship on surgical career interest.

**Results** Among 132 medical students (77 men and 55 women) who rotated through preclinical clerkship in our department, 125 participated in the survey and 66% expressed interest in a surgical career. In the post-clerkship survey, an increased interest in a surgical career was expressed by 79% of the students; notably, including those who initially expressed interest. Approximately 77% of students were satisfied with the practical skill training they received.

**Conclusion** Engaging medical students early in surgical experience through a preclinical clerkship for general surgery appears to promote their interest in a surgical career.

**Keywords** Surgery · Medical students · Education · Pre-clinical clerkship · Career

## Introduction

Since the introduction of the new postgraduate medical education system in Japan in 2004, the number of applicants for surgical residency programs has declined [1]. In Japan, medical school graduates are mandated to rotate through several departments during their first 2 years [2]. Once they have successfully completed the clinical resident training system, they enter a residency program based on their preferred specialty [2]. In recent years, there has been a worldwide trend of declining numbers of applicants for surgical residency programs [3–6]. According to the National Resident Matching Program in the United States, the match rate

in general surgery categorical residents has declined by 13% since 1994 [5].

Several factors may account for the declining interest in general surgery, such as a lack of mentorship, hostile work environment, gender differences, and the duration of mandatory training to become independent surgeons [4]. Varghese et al. reported that increased exposure to surgical experience during a student's preclinical years may encourage medical students by inducing a greater interest in general surgery [7]. Therefore, efforts should be made to involve medical students early in interesting surgical programs [8].

There have been several methods reported to provide medical students with early surgical experience [9, 10]. Alkatout et al. reported that the early involvement of medical students in a scientific congress had a positive impact on learning motivation and decision-making for a career in surgery [9]. Participating in a laparoscopic surgery training course was also reported to cultivate an interest in surgery [10]. On the other hand, some studies have shown that stereotypes and misconceptions may negatively influence students' career choices [11]. Stereotypes of the culture related

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to surgery, such as its competitiveness, male dominance, and the need for self-sacrifice, as well as the perceived self-confidence of surgeons and their intimidating demeanor may prevent graduates from seeking a career in surgery [11]. However, it has also been reported that once students encounter surgeons with whom they are able to discuss their professional and personal lives favorably, their perception of the surgical profession may be enlightened [12].

We hypothesized that an interesting surgical preclinical clerkship program could effectively cultivate medical students' interest in a surgical career. The aim of this study is to investigate how medical students perceive surgeons, and to evaluate the effect of a surgical preclinical clerkship program. This is the first report on students' perception of surgeons and the effect of preclinical surgical experience on medical students in Japan.

## Methods

### Participants and surgical clerkship program

Our institution, the International University of Health and Welfare (IUHW), Narita Hospital, is the newest university hospital in Japan, having opened in April 2020. The International University of Health and Welfare medical school was established before the hospital in 2017. Our university is unique in that it provides an unprecedented style of medical education, with emphasis on internationalism. Every year, we welcome approximately 140 medical students, consisting of 120 selected students from Japan and 20 international students recommended by their governments, mainly from East Asian countries. All international students studying medicine in Japan aim to become doctors by passing the Japanese national examination. All students are trained using active learning systems including English lectures, which may differ from the traditional Japanese educational system.

All undergraduate medical students start preclinical clerkships in their fourth year, at several affiliated hospitals. During their fifth year, they are required to participate in clinical clerkships at our institution's gastrointestinal surgery department. All students who participated in the clerkship in our department between April 2021 and March 2022 were included in this study.

Students were divided into small groups of six to eight and rotated through every department during the year. During the 2 week clerkship (10 days), we included a training program for surgical sutures, laparoscopic surgery, and robot-assisted surgery. We assigned all students to oversee a single patient's care and to accompany the attending physician during daily treatment of the patient, including surgery. At various operations, they performed skin closure and some other procedures involving surgical skills. Although

the clerkship was held during the COVID-19 pandemic, it was conducted in person with adequate preventive measures in place under hospital guidelines.

### Study design

We conducted a survey using a paper-based questionnaire in Japanese, distributed before and after the clinical clerkship. On the first day of the clinical clerkship, a single mentor explained the curriculum of the clerkship and asked all students to complete the three-part survey. The mentor explained that the aim of the survey was to assess their perception of issues related to surgeons, and evaluate the contents of clerkship for further improvement and creation of attractive programs. The mentor collected Section 1 of the survey on the second day of the clerkship, and Section 2 and 3 on the last day.

Our questionnaire comprised three sections (see the English version in Table 1). Sections 1–1 and 1–2 aimed to assess the students' interest in surgery and their perception of surgeons, prior to starting the clinical clerkship, and Section 1–3 assessed their previous experience of performing medical or surgical procedures. Section 2 required a record of scores received by the student during the training program. Section 3 aimed to assess the students' perceived level of achievement for each surgical procedure learned during the clerkship and evaluate any change in their opinion of surgeons. We included several questions for each section followed by blank sections for the students to express their opinions. This was our first survey of medical students, and we included 17 questions to evaluate their perceptions of surgery including working environment, training, personal characteristics, and lifestyle. Sex distinction was required for all parts of the survey, and the students were given the option to provide anonymous feedback by omitting their name from the questionnaire if they preferred, except in Section 1–3, 2, and 3–1, where we asked for an account of their individual experience of surgical procedures. We used a 5-scale score (5, strongly agree; 4, agree; 3, neutral; 2, somewhat disagree; 1, disagree) for Sections 1–2 and 3, and another 5-scale score (5, more than 5 times; 4, more than 3 times; 3, once or twice; 2, have seen this procedure before; 1, never) for Section 1–3 when answering the questionnaire. In Section 1–1, we asked students about their level of interest using a 5-scale score (5, extremely interested; 4, interested; 3, neutral; 2, not highly interested; 1, not interested at all). We considered students who answered with a score of 4 or 5 to the question about the level of interest in surgery in the survey to be interested in surgery. We compared the questionnaire results between students who were interested in surgery (interested group) and those who were not (non-interested group). We also compared results between sexes and between international students and Japanese students. Furthermore, we

**Table 1** Original questionnaire translated from Japanese to English

**1-1 Before starting a clinical clerkship**

We would appreciate your participation in this survey to help us create an interesting clinical clerkship taking your opinions into consideration.

1. Sex.	<input type="checkbox"/> Male	<input type="checkbox"/> Female
2. Name (optional)		
3. Are you interested in working in a field related to surgery?		
<input type="checkbox"/> Not interested at all	<input type="checkbox"/> Not highly interested	<input type="checkbox"/> Neutral
<input type="checkbox"/> Interested	<input type="checkbox"/> Extremely interested	
4. Please choose departments you are interested in for your future career. You can choose as many answers as you like.		
<input type="checkbox"/> Cardiology	<input type="checkbox"/> Cardiac Surgery	<input type="checkbox"/> Vascular Surgery
<input type="checkbox"/> Gastroenterology	<input type="checkbox"/> HBP & Gastrointestinal Surgery	<input type="checkbox"/> Neurology
<input type="checkbox"/> Orthopedics	<input type="checkbox"/> Nephrology	<input type="checkbox"/> Renal and Urological Surgery
<input type="checkbox"/> Infectious Diseases	<input type="checkbox"/> Obstetrics and Gynecology	<input type="checkbox"/> General Medicine
<input type="checkbox"/> Psychiatry	<input type="checkbox"/> Pediatrics	<input type="checkbox"/> Pediatric Surgery
<input type="checkbox"/> Dermatology	<input type="checkbox"/> Ophthalmology	<input type="checkbox"/> Otorhinolaryngology, Head and Neck Surgery
<input type="checkbox"/> Radiology	<input type="checkbox"/> Clinical Laboratory	<input type="checkbox"/> Emergency Room
<input type="checkbox"/> Pulmonology	<input type="checkbox"/> Pulmonary Surgery	<input type="checkbox"/> Neurosurgery
<input type="checkbox"/> Diabetes, Metabolism and Endocrinology	<input type="checkbox"/> Allergy and Rheumatology	<input type="checkbox"/> Hematology
<input type="checkbox"/> Oncology	<input type="checkbox"/> Breast Surgery	<input type="checkbox"/> Plastic and Reconstructive Surgery
<input type="checkbox"/> Anesthesiology and Intensive Care Medicine	<input type="checkbox"/> Anatomic Pathology	
<input type="checkbox"/> Others ( )		
5. Please let us know what you want to learn through this clinical clerkship. You can choose as many answers as you like.		
<input type="checkbox"/> Surgery	<input type="checkbox"/> Suture training	<input type="checkbox"/> Training using a simulator (laparoscopic and robotic surgery)
<input type="checkbox"/> Seeing patients' rounds	<input type="checkbox"/> Endoscopy	<input type="checkbox"/> Outpatient clinics
<input type="checkbox"/> Lectures for surgical disease		
If you have any other opinion, please write it down.		
6. What are your concerns about becoming a surgeon? Please express your honest opinion.		
7. What kind of support system do you believe is necessary for surgeons to balance their career with life events such as childbirth, marriage, and childcare? Please express your honest opinion.		

investigated if initial skill levels or the timing of rotation in our department affected the students' perception of surgery and the extent of satisfaction.

In the surgical suture program, students learned interrupted suturing and demonstrated their skill. A single mentor evaluated their skills on a scale of 1 to 5 at the beginning and end of the program. Our evaluation criteria were defined as follows: 1, no previous experience and required instruction for the entire procedure; 2, unable to perform the entire procedure independently; 3, able to perform more than half of the procedure independently with little instruction; 4, able to perform almost all of the procedure independently; 5, able to perform the entire procedure independently with a high level of skill. In the laparoscopic surgery training program, students performed laparoscopic cholecystectomy

using the LAP Mentor™ III (Surgical System, Drakegatan, Sweden). In the robotic surgery training program, students were subdivided into two groups of three to four and after the mentor provided instructions on using the DaVinci surgical system, they were asked to demonstrate tasks using the DaVinci surgical system. We asked students to perform the robotic surgery task several times and to record their scores each time they finished. The first task was Seaspiques, in which students would perform the task by transferring rings to each triangular corn. After repeating this task several times, they could select any task they liked. All practical training was scheduled in 1 h sessions with a single mentor teaching and providing advice. Figure 1 shows the scheme of our clerkship.

**Table 1** (continued)**1-2 Before starting a clinical clerkship**

Please let us know your perceptions of surgeons and their work environment.

1. Sex.	<input type="checkbox"/> Male	<input type="checkbox"/> Female	2. Name (optional)	Name :	
3. What do you think about the statements below related to your image to surgeons and surgeons' job.					
(1) Surgeons must work long hours.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(2) Surgeons need a long time to become independent.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(3) Surgeons need to have physical strength.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(4) The work of a surgeon can be dangerous.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(5) Surgeons need to be skillful.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(6) Surgeons need to have good judgment.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(7) Surgeons have to do a lot of emergency work.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(8) Surgeons need to have off-the job training.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
4. What do you think about the statements below related to the working environment of surgeons.					
(1) Surgeons are well supported for lifestyle events.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(2) There is no gender difference to becoming a surgeon.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(3) You may have objection from your family to become a surgeon.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
5. What do you think about the statements below related to the motivation of surgeons.					
(1) Surgeons love surgery.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(2) Surgeons feel accomplishment in work.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(3) Surgeons dislike teaching juniors.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(4) Surgeons have future demands.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(5) Surgeons have future prospects.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
(6) Learning surgical skills from the time of being a medical student is effective for a future surgical career.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree

Study approval was obtained by the Ethics Committee of the International University of Health and Welfare, Narita Hospital, Japan, before the commencement of this study (Institutional Review Board number 21-Nr-010).

### Statistical analysis

Statistical analyses were done using SPSS Statistics, version 25 (IBM Corporation, Armonk, NY, USA). We used the Student's *t* test and  $\chi^2$  test to analyze continuous variables, and Fisher's exact tests for categorical variables. We used a paired *t*-test or one-way analysis of variance (ANOVA) test to compare difference in scores at the commencement and on completion of the surgical training program. Differences were considered significant at a *P* value of  $<0.05$ .

### Results

A total of 132 medical students participated in clinical clerkships in our department between April 2021 and March 2022. They comprised 117 Japanese and 17 international students, 66% of whom expressed an interest in a career

related to surgery, with no significant difference in sex distribution (male 67%: female 65%,  $P=0.847$ ; Fig. 2). A total of 125 students (93%) completed Sect. 1 of the survey which assessed their perception of surgeons. Hepato-Biliary-Pancreatic & Gastrointestinal Surgery was the most selected field among all departments as a possible future career (28%), followed by Cardiology (23%), then Orthopedics (20%) (Fig. 3). Many students were interested specifically in clerkship programs related to surgery (53%), suture training (80%), and simulator training (74%) (Fig. 4).

The most dominant concerns about becoming a surgeon were the muscle strength required and the challenges of life-work balance (Fig. 5a). Students described the necessary support for a good life-work balance of a surgeon to be a flexible working arrangement, a substantial system for major life events, and a system for reinstatement in work after leave (Fig. 5b). Despite having negative images of a surgeon's working environment, they had a positive view of the future demands of surgeons and their prospects. Table 2 summarizes the results of the perception of surgeons according to the levels of interest in surgery. The interested group considered significantly more often than the less interested group that surgeons experience a sense of accomplishment

**Table 1** (continued)

**1-3 Before starting a clinical clerkship**

Listed below are procedures related to surgery we would like you to learn or experience through the clinical clerkship. Let us know your previous experience of each procedure. We will refer to your experience and make sure you can learn as many things as possible through our clinical clerkship.

1. Sex.	<input type="checkbox"/> Male	<input type="checkbox"/> Female	2. Name	Name:	
3. How many times have you performed the following procedures.					
Insertion of urethral catheter	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Disinfection of the surgical field	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Scrubbing for surgery	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Suturing of the wound	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Being a scopist in surgery	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Applying a wound dressing after finishing surgery	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
4. How many times have you performed the following procedures related to the daily care of postoperative patients.					
Daily wound dressings	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Removing a drain	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
5. How many times have you performed the following procedures related to surgical training.					
Knot-tying	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Instrument knotting	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Training using a DaVinci simulator	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.
Training using a laparoscopic simulator	<input type="checkbox"/> Never	<input type="checkbox"/> Have seen this procedure before	<input type="checkbox"/> Once or twice	<input type="checkbox"/> More than 3 times.	<input type="checkbox"/> More than 5 times.

**Table 1** (continued)

**2. Self-evaluation during the clerkship (DaVinci simulator)**

Let us know your evaluation scores from the clerkship.

We would like to know the change in scores throughout the clerkship. Your reported scores will not be reflected in the final grades.

1. Sex.	<input type="checkbox"/> Male	<input type="checkbox"/> Female
2. Name (optional).	Name :	
3. Please tell us what task you practiced and the scores you received initially, and all scores you received subsequently.		
Name of the task	The first score	Subsequent scores

( $P=0.015$ ). Table 3 shows how male and female students perceived surgeons. Female students often expressed concerns about how gender differences may impact on becoming a surgeon ( $P=0.001$ ). Female students also expressed a

preference for earlier training programs, starting before graduation ( $P=0.032$ ), and they considered significantly more often that surgeons need to have good judgment ( $P=0.020$ ), and experience a lot of emergency work ( $P=0.010$ ). We also

**Table 1** (continued)**3-1 Evaluation of achievement through the clerkship**

Tell us your experience after participating in the clerkship. Was our clerkship program effective for learning or building experience in each of the listed procedures?

1. Sex.	<input type="checkbox"/> Male	<input type="checkbox"/> Female	2. Name (optional)	Name :	
3. Was this clerkship effective in building your experience in the following listed procedures?					
Insertion of urethral catheter	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Disinfection of surgical field	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Scrubbing in for surgery	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Suturing of the wound	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Being a scopist in surgery	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Applying a wound dressing after finishing surgery	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
4. Was this clerkship effective in building your experience in the following listed procedures?					
Daily wound dressing	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Removing a drain	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
5. Was this clerkship effective in building your experience in the listed surgical procedures?					
Knot-tying	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Instrument knotting	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Training using a DaVinci simulator	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree
Training using a laparoscopic simulator	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree	<input type="checkbox"/> Strongly agree

divided the 115 students who provided their name on the survey into groups of international students (14 students) and Japanese students (101 students) and compared the results. The vast majority (93%) of international students expressed an interest in surgery. The general perception about surgeons was similar among international students and Japanese students, and our results revealed that international students significantly more often prioritized the importance of surgical skill ( $P=0.038$ , Table 4).

Table 5 summarizes the results of the survey asking about the students' previous experience. Almost all the students lacked experience in simulator training. The students who showed interest in a surgical career had significantly more experience in the daily care of surgical patients. The results of the survey investigating the effect of the clerkship on each procedure showed high satisfaction with training related to surgical skills in both the interested and non-interested groups (Table 6). We also compared the results among the former, middle, latter groups (47, 40, and 39 students respectively) divided based on the timing of those students being rotated to our department. No significant difference was found in their initial interest in surgery ( $P=0.574$ ) or the degree of changes through our clerkship ( $P=0.157$ ), or in perceptions ( $P=0.608$ ) among these groups after completing the clerkship program.

Figure 6 shows the results of the practical training. Only 58% of the students were ranked higher than 3 in suturing technique by a 5-scaled evaluation at the beginning of the training; however, almost all the students ranked higher than 3 by the completion of the training, with a significant improvement noted in all groups (Fig. 6a). There was also a significant difference in the evaluation scale initially, between the interested and non-interested groups. The percentages of participants who scored higher than 3 on a 5-point scale in the interested group and non-interested groups were 60% and 53%, respectively;  $P=0.042$ ; Fig. 6b-1; however, there was no significant difference in the evaluation of achievement score at the completion of the training class (interested group 98% vs. non-interested group 100%,  $P=0.213$ ; Fig. 6b-2).

During robotic surgery training, the advantage score of the tasks increased significantly for all groups with the number of times the tasks were repeated (Fig. 7). Initially, the scores of the tasks tended to be higher for students in the interested group and for male students (Fig. 4a-1, b-1); however, there was no significant difference in the average highest score between the two groups (Fig. 7a-2, b-2).

A satisfaction survey performed at the end of the clinical clerkship showed that 79% of the students had become more interested in a surgical career, especially those who initially

**Table 1** (continued)

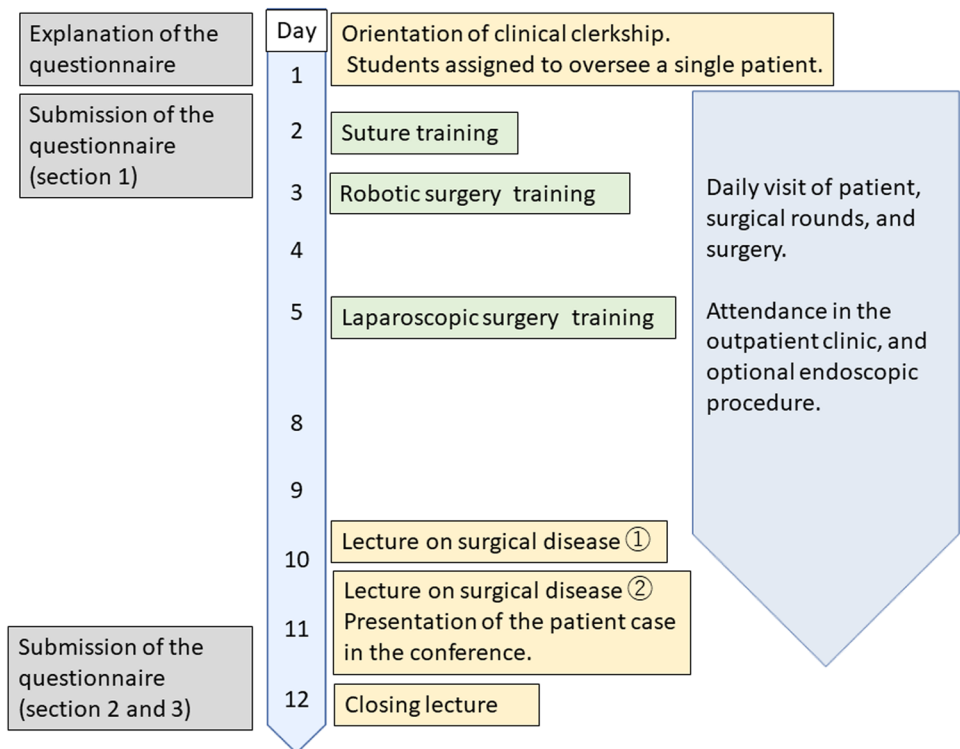
**3-2 Perception of surgeons after finishing the clerkship**

Tell us if there were any changes in your perceptions of surgeons after finishing the clinical clerkship.

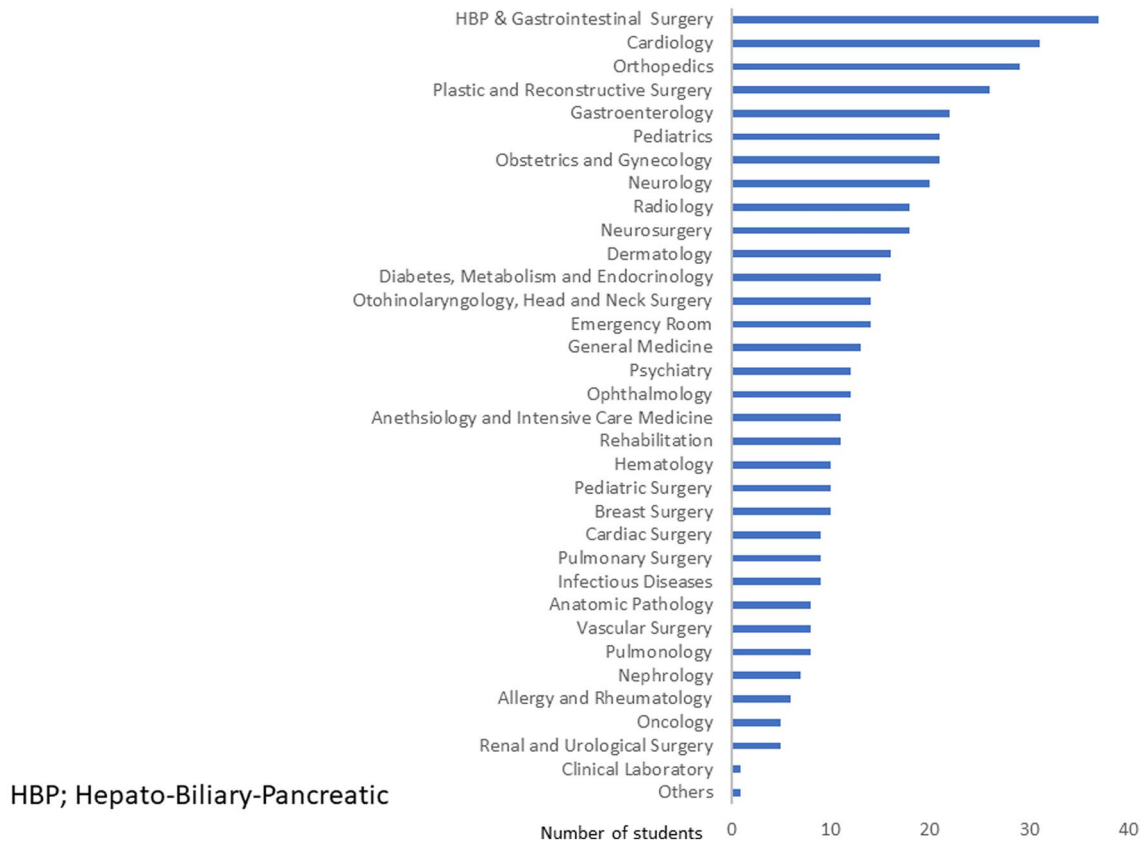
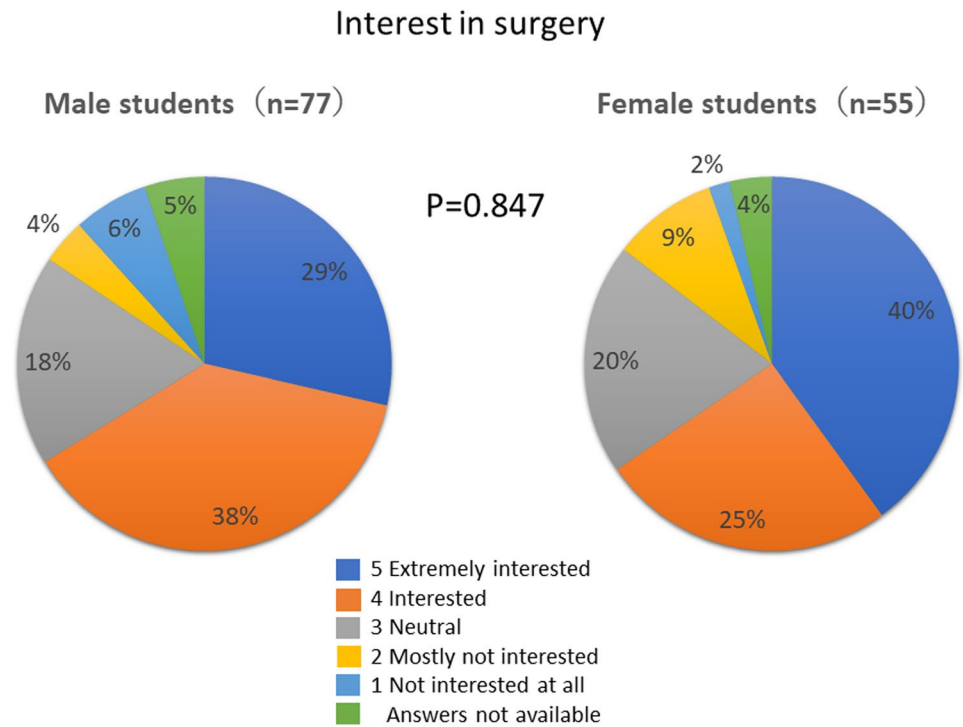
1. Sex.	<input type="checkbox"/> Male	<input type="checkbox"/> Female	2. Name (optional).	Name :
3. Do you agree with the statements below related to the impact of our clinical clerkship on you.				
The clerkship made me more interested in surgery.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
The clerkship taught me surgical procedures.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
The clerkship made me change my perception of surgeons and surgery. If you have specific examples of what changed your mind, please explain in the space below.	<input type="checkbox"/> Disagree	<input type="checkbox"/> Somewhat disagree	<input type="checkbox"/> Neutral	<input type="checkbox"/> Agree <input type="checkbox"/> Strongly agree
	Free blank:			
4. Please let us know what you think was beneficial to you in the clerkship.				
5. Please let us know if there is anything that should be improved in the clerkship.				
6. Please let us know if you have any other opinions.				

Thank you for your participation.

**Fig. 1** Scheme of the timeline of our clinical clerkship



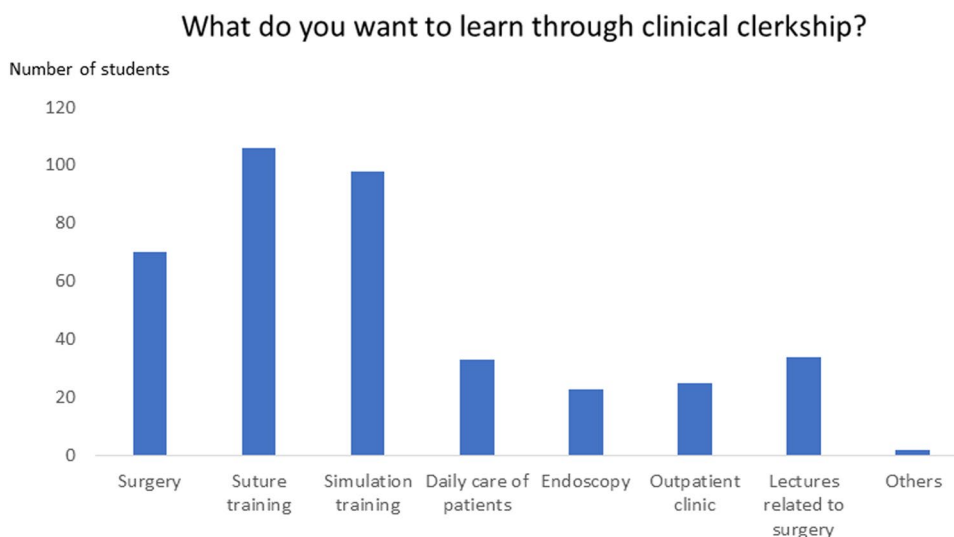
**Fig. 2** Amount of interest in surgery among male and female medical students



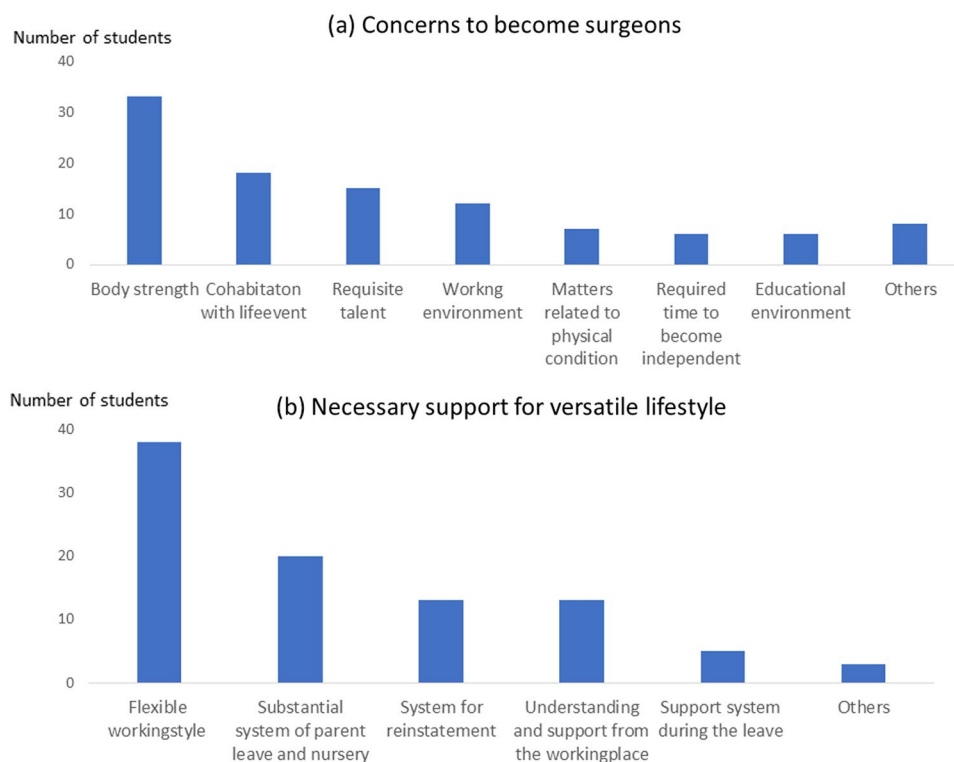
**Fig. 3** Student interest in medical fields for their future career



**Fig. 4** Responses from the pre-clerkship survey about what students wish to learn through their clinical clerkship



**Fig. 5 a** Responses from the pre-clerkship survey about student concerns regarding becoming surgeons. **b** Responses from the pre-clerkship survey about necessary support for a versatile work–life balance in a career in surgery



showed interest in a surgical career ( $P=0.026$ ) (Fig. 8a). On answering the question, “What you think was beneficial in the clerkship,” approximately 77% of students wrote in the blank space for comments that surgical training programs were most beneficial in our clinical clerkship. Some also commented that our clerkship was beneficial to promote a favorable attitude (8%) or to acquire knowledge of surgery (4%). More than 70% of the students expressed that they were able to acquire surgical skills through the clinical clerkship (Fig. 8b), and 37% reported change in their perception of surgeons, with a high

tendency in the non-interested group ( $P=0.052$ ) (Fig. 8c). Fifteen students gave us reasons for their changes in perception, mentioning changes in their view of surgeons ( $n=4$ ) or what is involved in the work of a surgeon ( $n=4$ ), and some mentioned that they liked the atmosphere of our department ( $n=8$ ). We also compared the degree of satisfaction based on the first scores of suture training (first score  $\geq 3$  or  $\leq 2$ ) and robotic surgery training (first score  $\geq 45$  or  $< 45$ ). The results revealed changes in the perception of surgeons by students with initially lower scores in suture training program (Fig. 9).

**Table 2** Results of the pre-clerkship survey: the interested group vs. the non-interested group

	Total (n = 125)	Interested group (n = 86)	Non-interested group (n = 39)	P value
<b>Characteristics of the surgeons' job</b>				
Surgeons must work long hours	4.23 ± 0.71	4.16 ± 0.71	4.36 ± 0.58	0.137
Surgeons need a long time to become independent	4.47 ± 0.59	4.47 ± 0.57	4.46 ± 0.64	0.975
Surgeons need to have physical strength	4.57 ± 0.54	4.57 ± 0.54	4.56 ± 0.55	0.957
The work of surgeons can be dangerous	4.13 ± 0.71	4.12 ± 0.64	4.00 ± 0.83	0.174
Surgeons need to be skillful	4.12 ± 0.63	4.06 ± 0.64	4.23 ± 0.58	0.153
Surgeons need to have good judgment	4.40 ± 0.55	4.40 ± 0.56	4.41 ± 0.55	0.890
Surgeons have a lot of emergency work	3.94 ± 0.78	3.95 ± 0.80	3.90 ± 0.75	0.711
Surgeons need to have off-the job training	4.42 ± 0.60	4.45 ± 0.61	4.36 ± 0.58	0.450
<b>Working environment of surgeons</b>				
Surgeons are well supported for lifestyle events	2.67 ± 0.73	2.73 ± 0.69	2.51 ± 0.79	0.119
There is no gender difference to becoming a surgeon	3.18 ± 0.96	3.16 ± 0.92	3.23 ± 1.06	0.716
You may have objection from your family to become a surgeon	2.47 ± 1.00	2.37 ± 0.99	2.64 ± 0.99	0.173
<b>Motivation of surgeons</b>				
Surgeons love surgery	4.36 ± 0.65	4.38 ± 0.60	4.28 ± 0.76	0.421
Surgeons feel accomplishment in work	4.51 ± 0.53	4.58 ± 0.52	4.33 ± 0.53	0.015*
Surgeons dislike teaching juniors	2.10 ± 0.82	2.06 ± 0.71	2.21 ± 1.03	0.356
Surgeons have future demands	3.41 ± 0.76	3.37 ± 0.80	3.51 ± 0.68	0.342
Surgeons have future prospects	3.83 ± 0.65	3.87 ± 0.67	3.74 ± 0.59	0.303
Learning surgical skills from the time of being a medical student is effective for a future surgical career	4.13 ± 0.77	4.20 ± 0.79	3.97 ± 0.71	0.135

Results are reported as means ± standard deviation of a 5-point scale defined as: 1 = Disagree, 2 = Somewhat disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree

**Table 3** Results of the pre-clerkship survey: male vs. female students

	Total (n = 125)	Male group (n = 72)	Female group (n = 53)	P value
<b>Characteristics of surgeons' role</b>				
Surgeons have to work long hours	4.23 ± 0.71	4.18 ± 0.72	4.30 ± 0.63	0.349
Surgeons need a long time to become independent	4.47 ± 0.59	4.47 ± 0.60	4.46 ± 0.57	0.931
Surgeons need to have physical strength	4.57 ± 0.54	4.53 ± 0.58	4.63 ± 0.49	0.287
The work of surgeons can be dangerous	4.13 ± 0.71	4.06 ± 0.79	4.24 ± 0.58	0.147
Surgeons need to be skillful	4.12 ± 0.63	4.03 ± 0.65	4.24 ± 0.58	0.059
Surgeons need to have good judgment	4.40 ± 0.55	4.31 ± 0.57	4.54 ± 0.50	0.020*
Surgeons have a lot of emergency work	3.94 ± 0.78	3.79 ± 0.80	4.15 ± 0.71	0.010*
Surgeons need to have off-the job training	4.42 ± 0.60	4.49 ± 0.56	4.34 ± 0.65	0.178
<b>Working environment of surgeons</b>				
Surgeons are well supported for lifestyle events	2.67 ± 0.73	2.65 ± 0.73	2.68 ± 0.72	0.805
There is no gender difference to becoming a surgeon	3.18 ± 0.96	3.43 ± 0.96	2.85 ± 0.86	0.001*
You may have objection from your family to become a surgeon	2.47 ± 1.00	2.41 ± 1.10	2.54 ± 0.86	0.492
<b>Motivation of surgeons</b>				
Surgeons love surgery	4.36 ± 0.65	4.36 ± 0.74	4.35 ± 0.52	0.934
Surgeons feel accomplishment in work	4.51 ± 0.53	4.53 ± 0.50	4.48 ± 0.57	0.638
Surgeons dislike teaching juniors	2.10 ± 0.82	2.19 ± 0.88	1.98 ± 0.71	0.137
Surgeons have future demands	3.41 ± 0.76	3.36 ± 0.77	3.48 ± 0.75	0.382
Surgeons have future prospects	3.83 ± 0.65	3.75 ± 0.71	3.93 ± 0.54	0.117
Learning surgical skills from the time of being a medical student is effective for a future surgical career	4.13 ± 0.77	4.00 ± 0.86	4.30 ± 0.60	0.032*

Results are reported as means ± standard deviation of a 5-point scale defined as: 1 = Disagree, 2 = Somewhat disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree

**Table 4** Results of the pre-clerkship survey: international vs. Japanese medical students

	Total (n = 115)	International students (n = 14)	Japanese students (n = 101)	P value
<b>Characteristics of surgeons' role</b>				
Surgeons must work long hours	4.22 ± 0.69	4.14 ± 0.66	4.23 ± 0.69	0.666
Surgeons need a long time to become independent	4.45 ± 0.58	4.43 ± 0.65	4.46 ± 0.57	0.872
Surgeons need to have physical strength	4.56 ± 0.55	4.38 ± 0.50	4.58 ± 0.55	0.148
The work of surgeons can be dangerous	4.10 ± 0.72	4.29 ± 0.47	4.08 ± 0.74	0.315
Surgeons need to be skillful	4.10 ± 0.63	4.43 ± 0.51	4.06 ± 0.63	0.038*
Surgeons need to have good judgment	4.40 ± 0.56	4.36 ± 0.63	4.41 ± 0.63	0.761
Surgeons have a lot of emergency work	3.93 ± 0.78	3.93 ± 1.00	3.93 ± 0.75	0.994
Surgeons need to have off-the job training	4.44 ± 0.58	4.36 ± 0.50	4.45 ± 0.59	0.577
<b>Working environment of surgeons</b>				
Surgeons are well supported for lifestyle events	2.67 ± 0.73	2.86 ± 0.86	2.64 ± 0.72	0.310
There is no gender difference to becoming a surgeon	3.17 ± 0.96	3.29 ± 0.91	3.16 ± 0.97	0.643
You may have objection from your family to become a surgeon	2.43 ± 1.00	2.43 ± 1.02	2.44 ± 1.00	0.980
<b>Motivation of surgeons</b>				
Surgeons love surgery	4.35 ± 0.65	4.50 ± 0.52	4.33 ± 0.66	0.352
Surgeons feel accomplishment in work	4.53 ± 0.52	4.57 ± 0.51	4.52 ± 0.52	0.754
Surgeons dislike teaching juniors	2.11 ± 0.84	2.29 ± 0.91	2.09 ± 0.83	0.412
Surgeons have future demands	3.38 ± 0.77	3.50 ± 1.02	3.37 ± 0.73	0.544
Surgeons have future prospects	3.83 ± 0.68	3.86 ± 0.53	3.82 ± 0.68	0.853
Learning surgical skills from the time of being a medical student is effective for a future surgical career	4.17 ± 0.78	4.21 ± 0.70	4.16 ± 0.80	0.804

Results are reported as means ± standard deviation of a 5-point scale defined as: 1 = Disagree, 2 = Somewhat disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree

**Table 5** Self-reported results from the clerkship survey assessing previous experience of surgical procedures

	Total (n = 124)	Interested group (n = 86)	Non-interested group (n = 38)	P value
Insertion of urethral catheter	3.27 ± 0.92	3.35 ± 0.96	3.08 ± 0.82	0.112
Disinfection of surgical field	3.41 ± 1.02	3.50 ± 0.98	3.21 ± 1.10	0.137
Scrubbing for surgery	4.87 ± 0.36	4.88 ± 0.36	4.85 ± 0.37	0.589
Suturing of the wound	3.33 ± 1.04	3.41 ± 1.00	3.15 ± 1.11	0.208
Being a scopist in surgery	2.58 ± 0.84	2.65 ± 0.81	2.44 ± 0.91	0.188
Applying a wound dressing after finishing surgery	2.86 ± 1.06	3.00 ± 1.06	2.56 ± 0.99	0.033*
Daily wound dressings	2.62 ± 0.94	2.73 ± 0.94	2.37 ± 0.88	0.048*
Removing a drain	2.55 ± 0.73	2.65 ± 0.76	2.32 ± 0.57	0.008*
Knot-tying	3.60 ± 0.96	3.70 ± 0.96	3.37 ± 0.94	0.079
Instrument knotting	3.07 ± 1.15	3.16 ± 1.18	2.86 ± 1.06	0.187
Training in using a DaVinci simulator	1.91 ± 0.86	1.91 ± 0.86	1.92 ± 0.85	0.933
Training in using a laparoscopic simulator	1.77 ± 0.82	1.78 ± 0.86	1.76 ± 0.75	0.922

Results are reported as means ± standard deviation of a 5-point scale defined as: 1 = Never, 2 = Have seen this procedure before, 3 = Once or twice, 4 = More than 3 times, 5 = More than 5 times

## Discussion

In Japan, graduates of the 6-year medical course are eligible to take the National Medical Practitioners Qualifying Examination, under the jurisdiction of the Ministry of

Health, Labor and Welfare. Those who pass this examination are qualified to begin clinical resident training [2]. The first 2 years of training may be equivalent to the internship year of American medical graduates or the foundation programs in the UK. It is a serious concern that the number of new

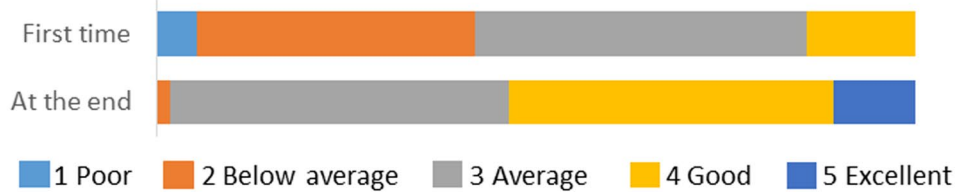
**Table 6** Effect of clerkship on proficiency in each surgical procedure

	Total (n = 112)	Interested group (n = 78)	Non-interested group (n = 34)	P value
Insertion of urethral catheter	3.76 ± 1.12	3.71 ± 1.15	3.94 ± 0.95	0.262
Disinfection of surgical field	4.19 ± 1.04	4.17 ± 1.07	4.29 ± 0.84	0.540
Scrubbing in for surgery	4.47 ± 0.61	4.53 ± 0.57	4.35 ± 0.69	0.173
Suturing of the wound	4.50 ± 0.67	4.55 ± 0.68	4.47 ± 0.61	0.583
Being a scopist in surgery	3,36 ± 1.02	3.46 ± 1.01	3.18 ± 0.97	0.178
Applying wound dressing after finishing surgery	4.12 ± 0.92	4.35 ± 0.88	3.85 ± 0.99	0.038*
Daily wound dressings	3.50 ± 1.06	3.65 ± 1.04	3.26 ± 1.02	0.071
Removing a drain	3.43 ± 1.22	3.68 ± 1.17	3.03 ± 1.17	0.008*
Knot-tying	4.42 ± 0.72	4.49 ± 0.72	4.32 ± 0.73	0.271
Instrument knotting	4.66 ± 0.50	4.73 ± 0.45	4.56 ± 0.50	0.091
Training in using a DaVinci simulator	4.57 ± 0.62	4.64 ± 0.63	4.44 ± 0.61	0.131
Training in using a laparoscopic simulator	4.48 ± 0.67	4.53 ± 0.70	4.38 ± 0.61	0.289

Results are reported as means ± standard deviation of a 5-point scale defined as: 1 = Disagree, 2 = Somewhat disagree 3 = Neutral, 4 = Agree, 5 = Strongly agree

Results of the suture training program (n=112)

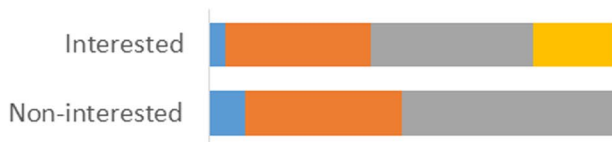
(a) All students



(b) Interested group vs. Non-interested group

(b-1) First time

P=0.042\*



(b-2) At the end

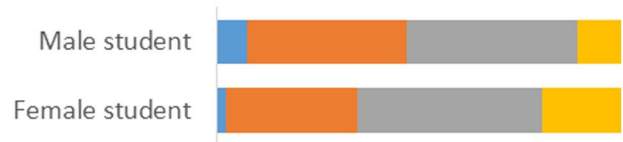
P=0.213



(c) Male students vs. Female students

(c-1) First time

P=0.052



(c-2) At the end

P=0.261

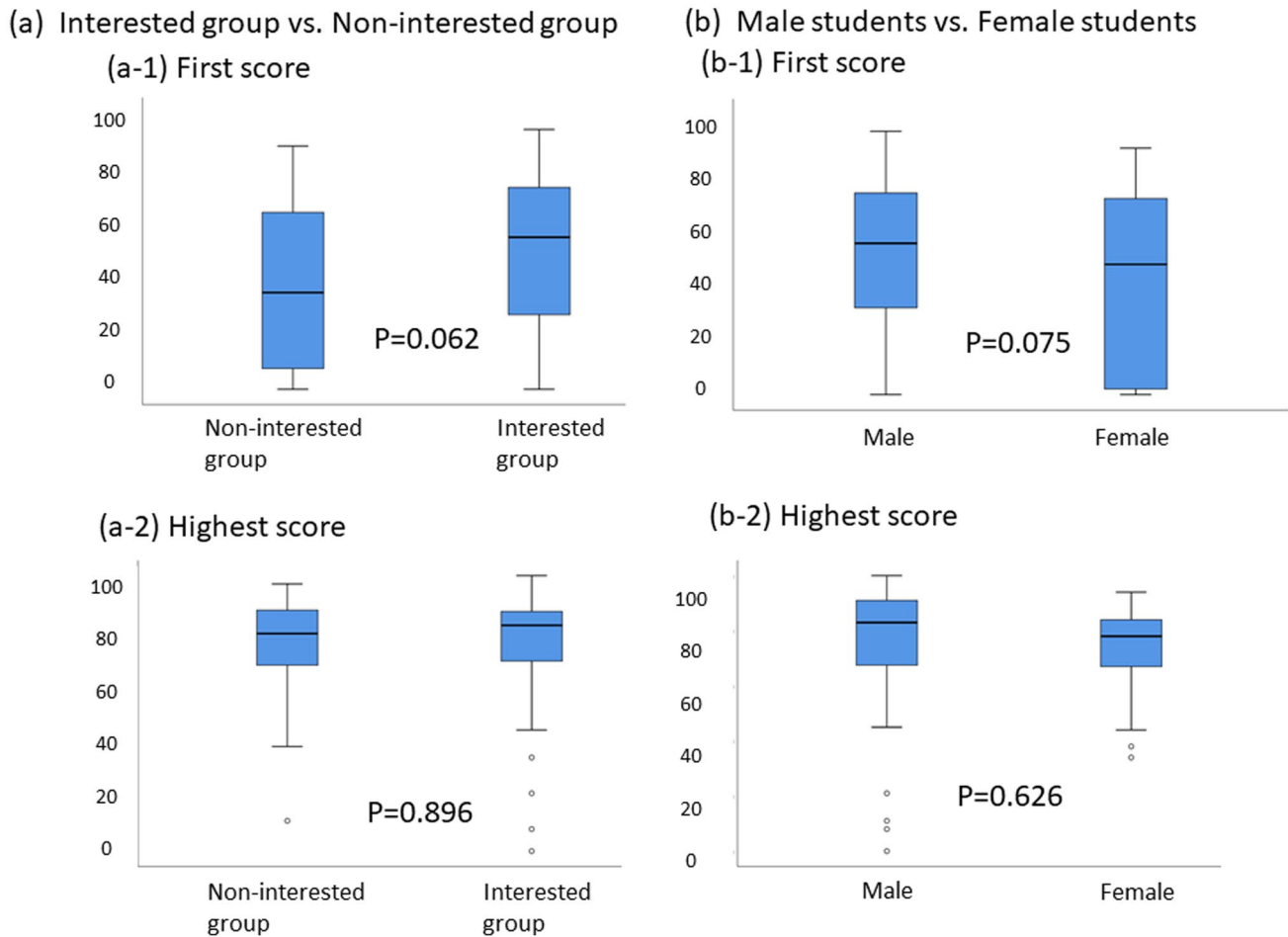


Legend: 1 Poor (blue), 2 Below average (orange), 3 Average (grey), 4 Good (yellow), 5 Excellent (dark blue)

**Fig. 6** Results of the suture training program. **a** For all students, the first time and on completion of the program. **b-1** For the interested group and non-interested group, the first time. **b-2** For the interested

group and non-interested group, on completion of the program. **c-1** For male and female students, the first time. **c-2** For male and female students, on completion of the program

## Results of the robotic surgery training program (n=104)



**Fig. 7** Results of the robotic surgery training program. **a** Results of the robotic surgery training program comparing the interested group and the non-interested group. **a-1** Initial scores in the interested group and the non-interested group. **a-2** Highest score in the inter-

ested group and the non-interested group. Results of the robotic surgery training program comparing male and female students. **b-1** Initial scores of the male and female students. **b-2** Highest scores of the male and female students

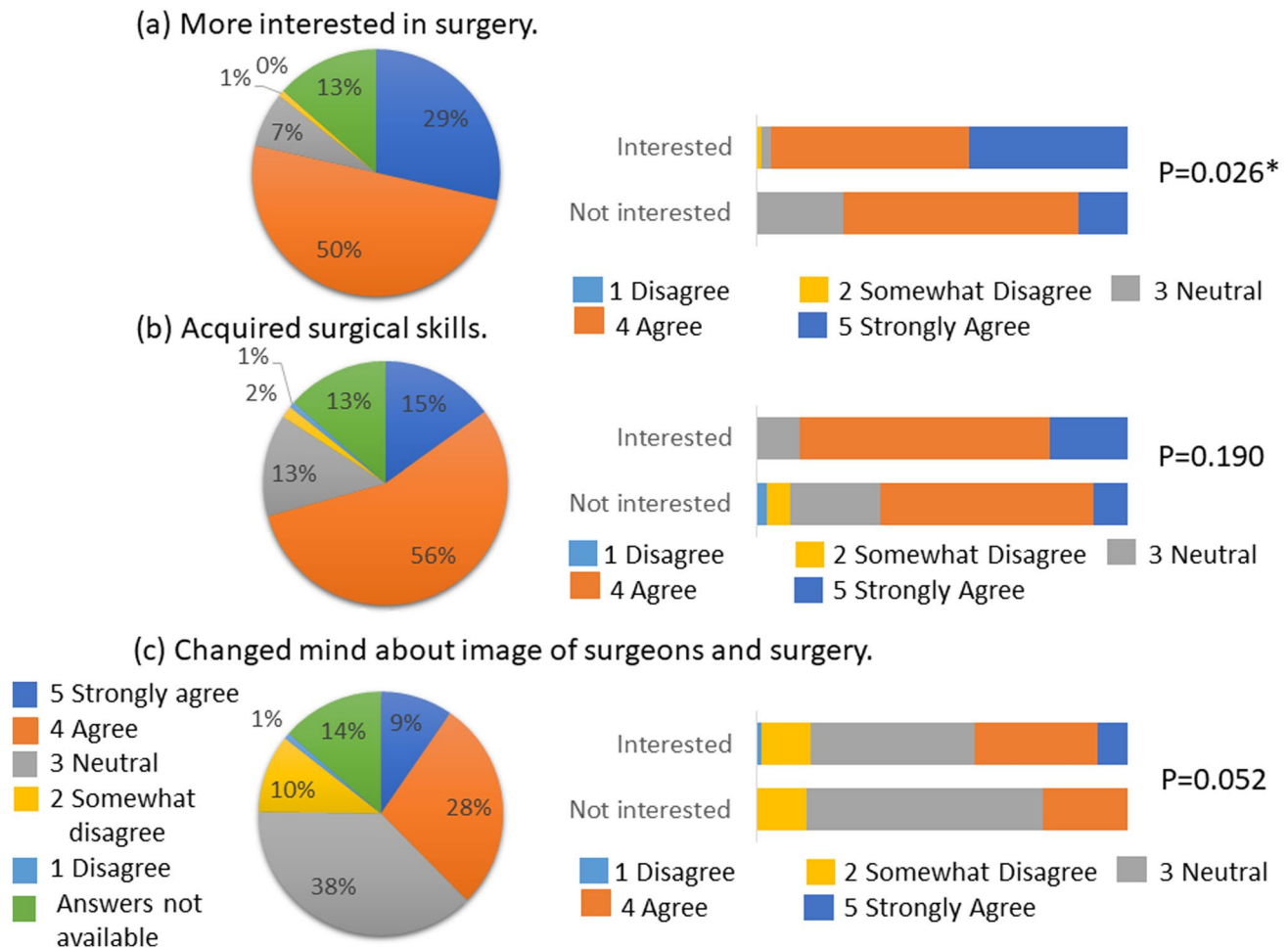
graduates choosing a surgical career in Japan has declined in the past 20 years [13]. To resolve this problem, we must identify an effective way to promote their interest in a surgical career. Previous studies have demonstrated that medical students' interest in surgery can be stimulated by increased clinical involvement in surgery [8, 11]. All medical students are required to attend preclinical clerkship programs in surgery; thus, providing an interesting program could positively influence their attitude toward surgical careers.

More than 60% of the students in this study expressed interest in a surgical career. Overall, the interested and non-interested groups had similar perceptions about the future or characteristics of surgeons. When comparing male and female students, female students seemed to be more anxious about the negative effect of gender differences on becoming surgeons. In the surgical skill training program, students in

both the interested and non-interested groups achieved an average level by the end of the class. The final satisfaction survey performed revealed the positive impact of clinical surgical clerkship for all students, especially those who were initially interested in surgery. Our survey identified a positive impact on the perception of surgeons, especially by students with lower scores at the commencement of the training program. Furthermore, among those who initially did not show any interest in surgery, a positive change was noted in their perception of a career in surgery. The responses of students showed the strong impact of clinical experience with surgical skills and practice on their attitudes.

Even though our curriculum was limited to 2 weeks, it had a positive effect on all students, motivating them to pursue a surgical career. Moreover, it is possible that the curriculum itself triggered an interest in surgery. On the other

## Results of the post-clerkship survey



**Fig. 8** Results of the post-clerkship survey. **a** Answers to the question asking about whether, “The clerkship made me more interested in surgery.” **b** Answers to the question asking about whether, “The

clerkship taught me surgical procedures.” **c** Answers to the question asking about whether, “The clerkship made me change my perception of surgeons and surgery.”

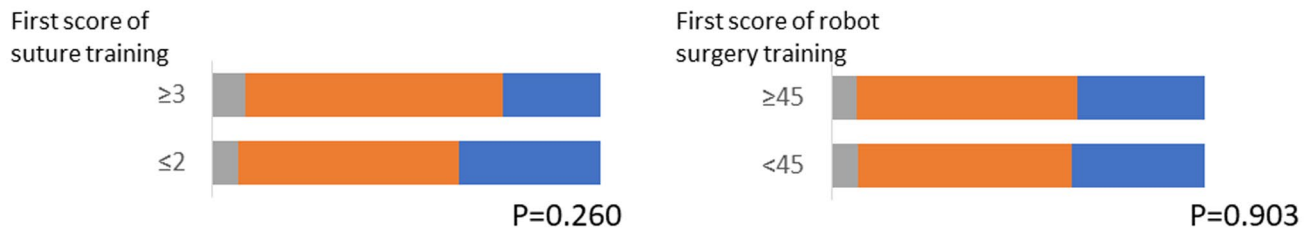
hand, most of our students had a negative perception about the surgeon’s environment. These perceptions may act as a barrier when they consider a surgical career in future. A previous report identified that many factors need to be improved in relation to the working environment for surgeons in Japan [13]. Efforts must be made to promote a better environment for surgeons by providing additional staff and reducing administration tasks [13].

The findings of our study also showed the possible impact of gender difference on the determination of surgical careers, especially for female students. In our study, many female students thought that surgeons need to have good judgment and that they have a high workload of emergency cases. These results may be related to a perception of the world of surgeons, including the effects of gender difference, which may make them deliberate more about becoming a surgeon. According to the results of a survey conducted by the Japan

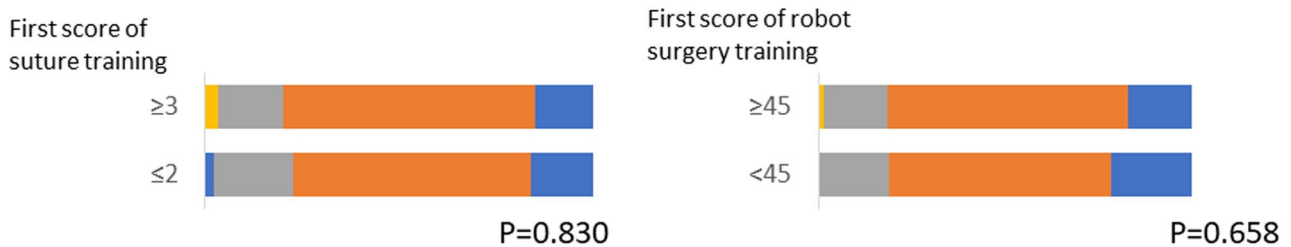
Surgical Society, there is still a significant difference in working styles between men and women working as surgeons in Japan [14, 15]. Many medical students responded to their experience of gender discrimination or gender privilege [16]. It has been reported that initiatives to promote awareness through “diversity and inclusion” lectures, were successful in fostering a better understanding [16]. In addition to developing an appealing program to promote future careers in surgery, we should devote ourselves to develop a more sustainable working environment for surgeons with a wide variety of styles. A 2-week clerkship cannot provide sufficient opportunity for students to understand everything involved in a career as a surgeon. To address their many concerns, including those related to gender difference or lack of support, we may give them some concrete examples or feedback such as the countermeasures we adopt, and our efforts toward further improvement. If we could provide more

## Results of the post-clerkship survey according to the first score in the training program

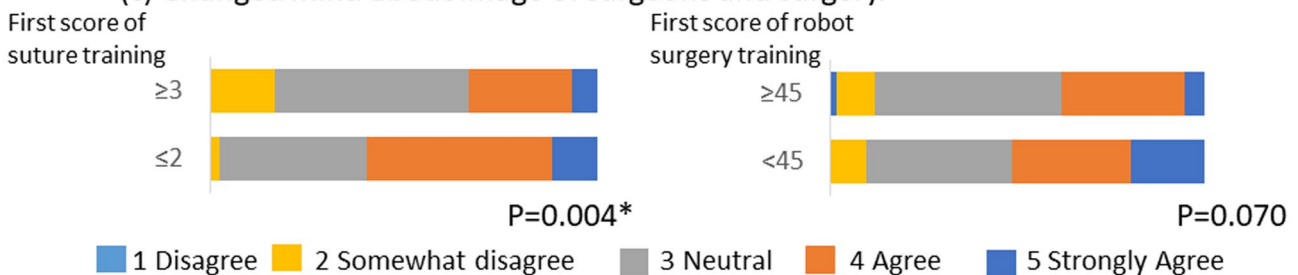
### (a) More interested in surgery.



### (b) Acquired surgical skills.



### (c) Changed mind about image of surgeons and surgery.



**Fig. 9** Results of the post-clerkship survey according to the first score in the training program. **a** Answers to the question asking about whether “The clerkship made me more interested in surgery.” **b** Answers to the question asking about whether “The clerkship taught

me surgical procedures.” **c** Answers to the question asking about whether “The clerkship made me change my perception of surgeons and surgery.”

concrete experiences and examples of a surgical career, they may feel reassured to consider pursuing a surgical career.

Our future study will focus on how we can maintain students’ interest or motivation in pursuing surgical careers, until they become doctors. Although many medical students showed interest in the beginning, it is still unclear how many will eventually choose surgical careers in future. It may be effective for us to provide regular classes or lectures related to surgery, so that they can always feel connected and assigned to a surgical field. We will continue tracking the careers of all these students and clarify how early exposure programs impact students seeking surgical careers after they graduate.

Some of our students were very curious about a surgical career. Previous studies have shown that early intervention in surgical skills training has been effective [3, 17, 18].

Although we ran some sessions on suture training before starting the clinical clerkship, earlier introduction of laparoscopic or robotic surgery training may be attractive for some students. For those with a strong interest in surgery, we can provide them not only with exposure to surgical skills, but also an early-oriented training program, which would be helpful to their careers. In our study, most female students showed a preference for an earlier training program. Early intervention can also enable them to learn and become independent faster, which may support a versatile career style in future. However, at present, only a few systematic programs are targeting medical students. Our further aim is to establish a systematic surgical training program that commences in the undergraduate period. This program itself can also be effective in constantly stimulating interest in surgery among students until they make their final career choice.

This study has some limitations. First, it was performed only on a single-year level of medical students. It is possible that the opinions may not sufficiently reflect those of all medical students in Japan. Nevertheless, we consider our results to be meaningful in revealing the possible impact of clinical clerkship on the perceptions of medical students. Second, this study was performed at only one point for each student. To identify the effect of surgical clerkship, it will be necessary for us to follow these students until they select their final specialty in future. However, this was a unique study that demonstrated the perception of surgeons among medical students and evaluated the short-term impact of clinical clerkship in Japan. Many medical students have a potential interest in surgery; therefore, we are responsible for making all possible efforts to provide medical students with an interesting program to foster their interest and motivation toward a career in surgery.

In conclusion, we can provide a positive image of surgical careers through an attractive preclinical clerkship program that focuses on experience of surgical skills. Efforts should be made to cultivate medical students' interest in surgery to encourage them to consider choosing a career in surgery in future.

**Acknowledgements** We thank all the medical students for their participation in our study.

**Funding** Not applicable.

## Declarations

**Conflict of interest** We have no conflicts of interest to declare.

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