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Outcomes of Mesh Plug Repair for Open Inguinal Hernia Performed by Resident Surgeons: Safety and Significance

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Abstract

Purpose

We investigated the outcomes of inguinal hernia repair performed by resident surgeons and explored the effects of this experience on the subsequent selection of specialties for advanced training.

Methods

Residents underwent surgical training, which included instructional surgical videos, before performing inguinal hernia repair. In this retrospective cohort study, patients were grouped according to the operating surgeon (resident vs. surgical staff), and patient characteristics and perioperative outcomes were compared between these groups. Career choices were self-reported 6 months after the residency rotation was completed.

Results

During the study period, residents performed 47 of 296 inguinal hernia repairs (16%). The recurrence (2.1% vs. 2.4%, P = 0.91) and postoperative complication rates (6.4% vs. 1.6%, P = 0.05) did not differ between residents and surgical staff. Before training, 6 of 18 residents intended to pursue surgery; however, 9 of 18 ultimately chose surgery as their career path.

Conclusion

With appropriate supervision, inguinal hernia repair can be safely performed by residents. Early exposure to surgery may be associated with increased interest in pursuing a surgical career.

1. Introduction

With ongoing advances in medicine, the number of techniques and procedures that surgical residents must master is rapidly increasing, but opportunities to practice these procedures remain limited [1]. Because of concerns regarding working hour restrictions and patient safety, the scope of clinical practice in which resident physicians can refine their skills is restricted [2, 3]. Nevertheless, it is important to allow resident physicians to gain experience in clinical settings and maintain the quality of medical care.

Inguinal hernia is among the most common surgically treated conditions, and inguinal hernia repair is among the first procedures performed in general surgery. Therefore, even residents can safely perform inguinal hernia repair under strict supervision. Performing this procedure as part of surgical training may help residents acquire basic surgical skills. However, postoperative complication and recurrence rates

repair must not increase when the procedure is performed by residents. Previous studies demonstrated that the post-graduation year influences the outcome of open inguinal hernia repair [4–6]. Recurrence rates were significantly higher for procedures performed by residents and young surgeons. Hence, experienced surgeons must guide these procedures carefully when the surgeon is a resident or young surgeon. Preoperative surgical videos have been reported to be useful for training [7]; therefore, they are incorporated into resident surgical education at our hospital.

Mesh plug (MP) repair is the most popular inguinal hernia repair method in Japan [8]. MP repair is relatively simple, reproducible, and associated with a low complication risk, making it suitable for resident training. Recurrence rates of 0.9%–7.8% have been reported for MP repair [6, 9–11]. Our department has allowed residents to perform inguinal hernia repair as part of their surgical training. Considering the limited reports on inguinal hernia radical surgery performed by residents, this study compared surgical outcomes between residents and surgical staff to evaluate the safety of resident-performed MP repair and determined whether early operative exposure influences residents' career decisions.

2. Methods

2.1. Patients and data collection

This study enrolled 267 patients with 296 inguinal hernia lesions who underwent MP repair between April 1, 2020, and March 31, 2024. Patients with recurrent hernias and those who previously underwent hernia repair were excluded. Data regarding patient age, sex, complications, operative time, blood loss, type of inguinal hernia, length of hospital stay, and postoperative recurrence were collected from medical records.

2.2. Ethics approval

This study was performed in accordance with the principles of the Declaration of Helsinki and approved by the Tokushukai Group Joint Ethics Review Committee (TGE02260-011). The need for informed consent was waived because of the retrospective nature of the study. However, an opt-out format was used. The research participants provided informed consent for the publication of their comments.

2.3. Surgeons

In this study, “residents” were defined as physicians in their first or second year after passing the national medical examination. In Japan, residents who pass the national medical examination must undergo 2 years of training, rotating through various departments (e.g., surgery, internal medicine, pediatrics, obstetrics and gynecology, and psychiatry). Our hospital has a 2–3-month surgical rotation program, in which resident doctors undergo surgical training. After completing 2 years of training, residents proceed to their respective specialties. Career choices were self-reported 6 months after completing the residency rotation. “Surgical staff” comprised physicians who had obtained a surgical or gastrointestinal surgical specialty. During the study period, MP repair was performed by 18 residents and

one member of the surgical staff (T.S). All MP repairs by residents were performed under the supervision of T.S. Patients were grouped according to the operating surgeon (resident or surgical staff group).

2.4. Surgical education

Residents first learn about inguinal hernia surgery through surgical textbooks. Additionally, they are trained on the inguinal hernia repair procedure through surgical videos. Any questions raised by resident physicians are explained and resolved. Next, the resident is assigned as the first assistant. The procedures for scalpel use and tissue preservation are explained, and each anatomical feature is confirmed. During surgery, any questions that arise are clarified and resolved. After the procedure, a review is conducted to confirm that the resident understood the procedure. Assistants were required to undergo at least five training sessions. Residents were only allowed to perform surgery when they were determined to have a sufficient understanding of inguinal hernias by surgeons. No clear criteria existed for this standard, and it was determined solely based on the subjective judgment of the surgeon.

2.5. Hernia repair

MP or iliopubic tract (IPT) repair was performed under general anesthesia for inguinal hernia in all cases in this study. An approximately 5-cm skin incision was made along the groin. The external oblique aponeurosis was incised, and the inguinal canal was taped. In cases of indirect hernia, the hernia sac was separated, and a Bard MP (C. R. Bard, Inc., Murray Hill, NJ, USA) was inserted into the hernia orifice after inverting the sac into the preperitoneal space. The size of the plug was determined according to the size of the hernia orifice. The plug was sutured to the transversal fascia with at least four stitches using 3 − 0 Vicryl (Ethicon; Johnson & Johnson, New Brunswick, NJ, USA). In cases of direct hernia, after separating the spermatic cord from the inguinal canal, the transversal fascia was opened throughout the entire surface of the hernia orifice. Next, the sac was inverted, and the plug was inserted into the preperitoneal space. The plug was sutured to the transversal fascia with at least four stitches as performed for indirect hernias. If the hernia sac was large, then it was transected, its central part was separated from the inguinal canal, and then it was closed. In both cases, the patch of the Bard MP was placed over the posterior wall of the inguinal canal sutured to the internal oblique muscle pubic tubercle and inguinal ligament using at least six stitches. After closing the external oblique and Scarpa’s fascia, the skin was closed with a running suture using 4 − 0 Vicryl. PT repair patients was performed for patients aged < 40 years. The hernia sac was treated as described for MP repair. IPT repair involves making an incision in the transverse fascia from the internal inguinal ring to the pubic tubercle, entering the preperitoneal space, and suturing the medial and lateral transverse fascia and the inguinal ligament using 4 − 0 Vicryl. After closing the external oblique and Scarpa’s fascia, the skin was closed with a running suture using 4 − 0 Vicryl.

2.6. Follow-up

All patients underwent follow-up at least once after discharge. We instructed all patients to return for a follow-up visit if they had any concerns after surgery. For patients with pain or discomfort in the surgical site after surgery, a follow-up examination 1 month after surgery was required. If symptoms persisted,

then follow-up examinations were conducted at 3, 6, and 12 months. Postoperative complications included bleeding, hematoma, and wound infection. Although chronic symptoms such as pain, numbness, and discomfort at the wound site were observed, they were considered only if they persisted for more than 1 month after surgery. Only pain requiring analgesics was considered, and this was not indicative of chronic pain. Only cases of numbness affecting the inguinal region were considered. Although chronic discomfort does not require painkillers; it was defined as discomfort that persisted for more than 1 month. Only recurrence occurring within 1 year of surgery was considered. If recurrence was suspected, confirmatory abdominal ultrasound or abdominal computed tomography was performed, and a definitive diagnosis was made.

2.7. Statistical analysis

Categorical variables were expressed as numbers with percentages and compared between the groups using the chi-squared test. Continuous variables were expressed as medians with ranges and compared between the groups using the Mann–Whitney U test. Multivariate analysis was performed using the Cox proportional hazards model for risk factors for recurrence. Variables significant at $P < 0.2$ in univariate analysis were included in multivariate analysis using the Cox proportional hazards model. Two-sided $P < 0.05$ indicated statistical significance. All statistical analyses were conducted using JMP version 12 (SAS Institute, Cary, NC, USA).

3. Results

3.1. Clinical characteristics of the patients

Table S1 summarizes the patients' demographic characteristics. During the study period, 47 lesions (16%) were surgically treated by residents. No significant differences in age, sex, location, operative diagnosis, European Hernia Society classification, and surgical procedure were detected between the groups.

3.2. Surgical outcome

As presented in Table S2, the median operative time was 59 min (interquartile range [IQR] = 29–91) for the resident groups, versus 30 min (IQR = 15–69) for the surgical staff group ($P < 0.01$), and the postoperative complication rates were 6.4% and 1.6% in the residents and surgical staff groups, respectively ($P = 0.05$). A detailed examination of postoperative complications revealed higher postoperative bleeding (2.1% vs. 0.4%) and hematoma rates (4.3% vs. 0.8%) for residents, whereas their wound infections rate was lower (0% vs. 0.4%). However, these differences were not statistically significant. The recurrence rate was 2.1% for the resident group and 2.4% for the surgical staff group ($P = 0.91$). Recurrence was evaluated within 1 year postoperatively in all patients.

3.3. Perioperative factors related to recurrence

The perioperative factors related to recurrence were evaluated by univariate and multivariate analyses (Table S3). The operator was not a significant perioperative factor associated with recurrence in univariate analysis. Similarly, direct hernias and postoperative complications were not significant risk factors associated with recurrence in multivariate analysis.

3.4. Residents' career paths and impressions

Before surgical training, 6/18 (33.3%) residents expressed a preference for surgical specialties (gastrointestinal surgery, neurosurgery, orthopedic surgery, plastic surgery, and emergency medicine), but nine (50%) residents ultimately chose surgical specialties (cardiovascular surgery, neurosurgery, orthopedic surgery, plastic surgery, and emergency medicine). (Fig. 1).

- Comment from Resident A

Performing the surgery deepened my understanding of anatomy. By performing the surgery, I was able to experience the real thrill of surgery. And I was able to truly appreciate the depth and difficulty of surgery. I was able to gain experiences that cannot be compared to studying from textbooks. I think studying with surgical videos was very helpful.

- Comment from Resident B

Watching the supervising doctor perform the procedure, it looked easy, but when I actually tried it myself, I found it quite difficult because the membranes all looked the same. However, by performing surgery, I felt that I had glimpsed some of the merits of surgery.

- Comment from Resident C

By performing the surgery, I felt a sense of accomplishment and was able to enjoy the experience. However, I realized how difficult the surgery was, and I recognized once again that long-term training is necessary to become a skilled surgeon. Studying with surgical videos was very easy to understand and beneficial.

- Comment from Resident D

I realized that various considerations are necessary when performing surgery. I was able to experience firsthand things that only an operator would understand, such as how much force to use when grasping fragile tissue and the ability to expand the surgical field.

4. Discussion

This study revealed a similar 1-year recurrence rate between patients who underwent inguinal hernia repair performed by residents and those surgically treated by surgical staff. According to univariate analysis, the operator was not a significant perioperative factor associated with recurrence. The literature reports recurrence rates of 0.9%–7.8% in inguinal hernia repair surgery [6, 9–11], which is

consistent with the present results. Hence, residents can safely perform MP repair for inguinal hernia without increasing the risk of recurrence. The low recurrence rate might be attributable to routine fixation of the onlay mesh to the pubic tubercle in all cases. Most cases of recurrence in this study involved direct inguinal hernias. Therefore, resident doctors should be instructed to ensure that this fixation is secure. However, further investigation is required.

Conversely, residents had significantly longer operative times and more complications than surgical staff. Specifically, the operative time for MP reinforcement was approximately twice as long, consistent with previous findings [12]. Residents learn surgical procedures through textbooks and surgical videos and participate in surgeries as assistants, believing that they understand the surgical techniques. Nonetheless, during surgery, residents encounter situations that differ from those described in textbooks. For instance, the thicknesses of the superficial abdominal fascia and external oblique aponeurosis and the difficulty in identifying the hernia sac vary significantly by case. Therefore, it is inevitable that training surgeries will require more time when providing guidance, although it is also important to set a time limit. For instance, Takahashi et al. reported that the average operative time for MP repair was 59.3 ± 19.6 min [6], whereas Hidalgo et al. recorded a mean operative time 56 ± 14 min for open repair [13]. Therefore, our hospital instructs residents to complete the surgery within 1 h. In cases in which taping of the inguinal canal is difficult, surgical staff may perform the procedure only in that area. However, this might not be applicable if there is only one surgery, and time might be required to provide guidance. At our hospital, we provide guidance on surgery using this method. Regarding postoperative complications and chronic symptoms, bleeding, hematoma, and pain were more common following surgeries performed by residents. Therefore, when resident physicians perform surgery, it is essential that care is taken to carefully perform hemostasis, gently handle tissues, and avoid damaging the ilioinguinal nerve. Altogether, under the strict supervision of surgical staff, resident physicians can safely perform MP repair surgery for inguinal hernias.

During resident education, it is important that the training surgeons provide several opportunities to perform general surgical procedures. However, it is equally important to ensure the quality of these procedures. Surgical education might help address this issue by reducing the incidence of complications, improving the quality of procedures, and increasing the proficiency of resident physicians. We use textbooks, surgical videos, and surgeries for education, and surgical videos might be particularly useful [7, 14, 15]. As residents also participate in ward management, outpatient care, and other tasks, they can watch the videos and train themselves at their convenience. Moreover, repeatedly watching the videos makes it easier to visualize the flow of surgery. For surgical staff, the availability of surgical videos might make education easier and more effective, as resident doctors can also undergo training to a certain extent in advance. Providing surgical training via video might increase opportunities for surgical training, enhance the safety of procedures, and maintain the quality of surgery.

In Japan, all medical school graduates who pass the National Medical Licensing Examination are required to complete 2 years of clinical training before practicing as physicians. During this training, residents rotate through all departments involved in diagnosis and treatment [16], after which they will

begin training as a specialist in general surgery, neurosurgery, internal medicine, or another field. The enrolled residents included individuals planning careers in both surgery and internal medicine. Although the number of residents choosing surgical specialties increased from 6 (6/18, 33.3%) to 9 (9/18, 50%) during the study period, we do not believe that this experience is the only reason, although it might have been useful. Although it is important to explain the advantages and disadvantages of a surgical career, allowing resident physicians to experience performing surgery could prompt some to enter surgical specialties. However, further research is necessary.

The limitations of this study included its retrospective, single-center nature, selection bias, and unverified self-reported data. Although qualitative insights are valuable, such observations are anecdotal, uncontrolled, and ungeneralizable. Moreover, the recurrence rate might have been underestimated because of the short postoperative follow-up period of only 1 year. Nonetheless, it has been reported that recurrence following MP reinforcement occurs generally within 1 year postoperatively [17]. Despite open, laparoscopic, and robot-assisted approaches [18–20], we chose open MP repair because it is easier and safer for teaching basic surgical techniques. Objective evaluation tools (e.g., surgical checklists and evaluation scores) were not always used to evaluate resident surgeons before surgery. Further research using objective evaluation tools is necessary in the future, and further data from large-scale studies are required to confirm these findings.

5. Conclusion

With appropriate supervision, resident-performed MP repair might be safe, although some differences in operative metrics were observed. Training with surgical videos is useful for surgical education, and early exposure to surgery might increase interest in surgical careers.

Declarations

Declaration of conflicting interests

I have nothing to declare.

Consent to Participate

The requirement for written informed consent was waived because this study was a retrospective analysis using de-identified data, in accordance with the policy of the institutional ethics committee. Individuals were guaranteed the right to opt out.

Consent to publish

The authors affirm that human research participants provided informed consent for publication of all Figures.

Data availability statement

The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

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Authors' contribution statement

Toshiyuki Suzuki: Study conception and design, Conceptualization, Methodology, Software, Validation, Acquisition of data, Formal analysis, Analysis and interpretation of data, Investigation, Resources, Drafting of manuscript, Writing – Original draft, Visualization, Project administration, Funding acquisition.

Daisuke Sugiki: Data curation, Supervision, Critical revision of manuscript.

Hiroshi Matsumoto: Writing – Review & editing, Critical revision of manuscript.

All authors approved the final version of the manuscript and agree to be held accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Figures

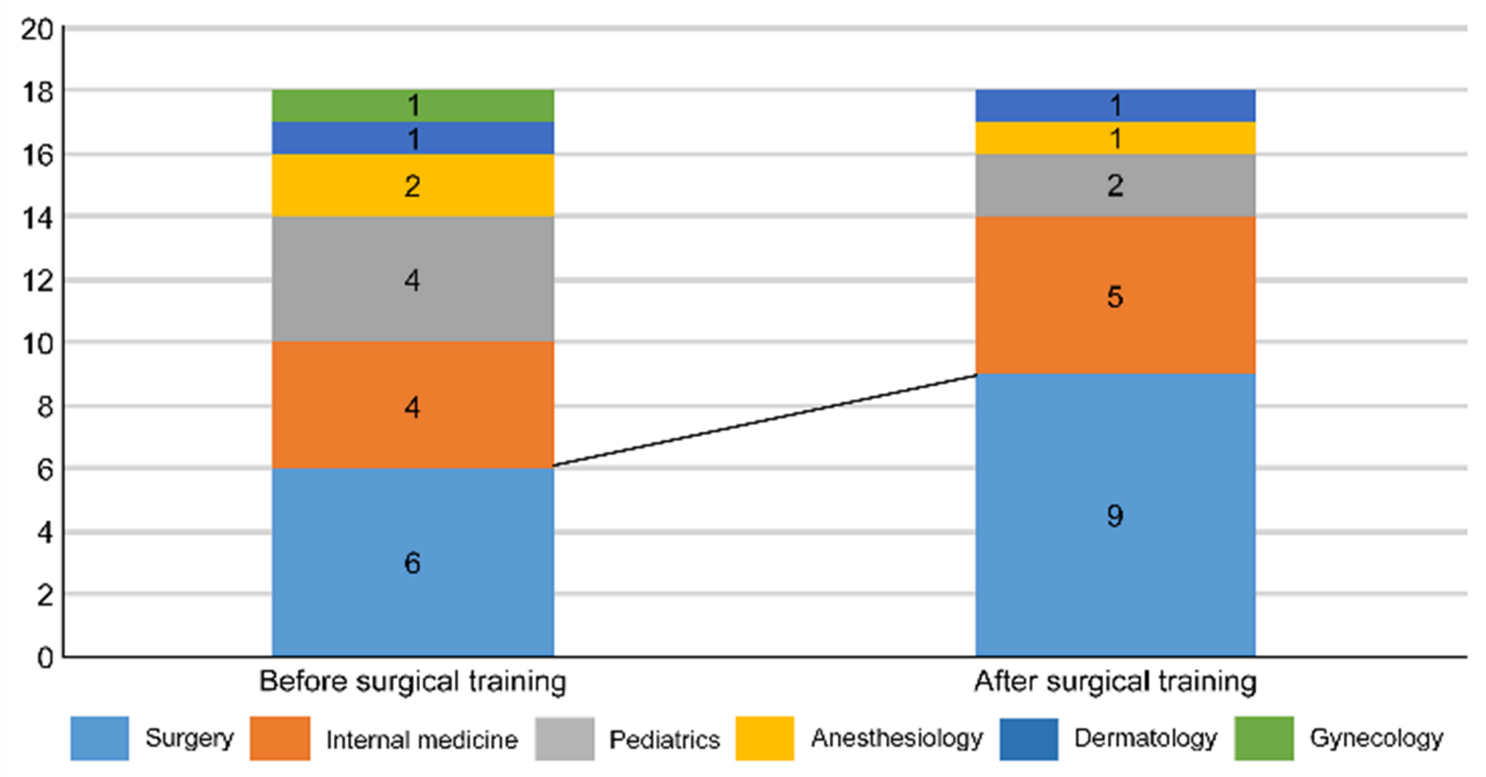


Figure 1

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