

ORIGINAL ARTICLE

The learning curve for laparoscopic totally extraperitoneal herniorrhaphy by moving average

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Purpose: Laparoscopic totally extraperitoneal (TEP) herniorrhaphy has been recognized as a treatment option for inguinal hernia. The objective of this study was to clarify the learning curve for laparoscopic TEP herniorrhaphy using the moving average method. **Methods:** A total of 90 patients underwent laparoscopic TEP herniorrhaphy by a single surgeon between March 2009 and March 2011. We analyzed medical records including the demographic data, operating time, hospital stay, and postoperative complications. **Results:** The mean operating time of the initial 30 cases (learning period group) was 66.3 minutes. After the initial 30 cases were performed, the time decreased to 52.8 minutes in the later 60 cases (experienced period group, $P=0.015$). This represents the operating time becoming stabilized and then decreasing as the number of performed cases accumulates. Hospital stay was shorter and frequency of pain control, and complication rate were lower in the experienced period, however, there was no statistical significance. **Conclusion:** We suggest that number of patients needed for the learning curve for laparoscopic TEP herniorrhaphy should be 30 cases. The operating time for laparoscopic TEP herniorrhaphy stabilizes after 40 cases in moving average analysis.

Key Words: Inguinal hernia, TEP, Laparoscopy, Learning curve, Moving average

INTRODUCTION

Inguinal hernias are the most common abdominal wall defects seen in surgical practice, with at least 700,000 cases of herniorrhaphy performed annually in the United States alone [1]. Approximately 2 to 5% of the total population suffered from hernia. The National Health Insurance announced the herniorrhaphy was popular surgery in Korea statically which were about 33,000 cases of herniorrhaphy was performed in 2010 alone [2]. Since introduction of inguinal hernia repair by Bassini in 1887, various inguinal

hernia repair methods have been introduced by many surgeons [3]. Among them, the original Lichtenstein repair described in 1984, the hernia was repaired with tension free fashion by suturing a prosthetic material to cover or bridge the defect in the floor of the inguinal canal and to recreate the internal inguinal ring [3]. Recently, totally extraperitoneal (TEP) repair and transabdominal preperitoneal (TAPP) repair are common performed as laparoscopic procedures to address inguinal hernias. In experienced hands, TEP and TAPP are associated with low recurrence rates in the range of 1 to 4% [1]. Also, laparo-

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scopic surgery is considered to reduce postoperative pain, incidence of wound complications and time to return to activities of daily living compared with open surgery [1,4].

In general, laparoscopic surgery is considered to be more difficult than open surgery because of the peculiarity of anatomy and limitation of working space. Furthermore, learning curve for laparoscopic TEP herniorrhaphy has a longer and steeper due to the “inside out anatomical view”: to which the surgeon is not accustomed [5]. The learning curve was assessed through operating time, postoperative complications, and technical difficulties in previous studies [6]. In the previous studies, operating time associated learning curve measurement has a bias depending on patient’s current conditions. In statistics, a moving average also called rolling average and the rolling mean running average. It is a type of finite impulse response filter used to analyze a set of data points by creating a series of averages of different subsets of the full data set. Simple moving average is a statistical process to compensate the bias.

The purpose of this study was to clarify the learning curve for laparoscopic TEP herniorrhaphy using moving average in single surgeon.

METHODS

Patients and materials

Total 90 patients underwent laparoscopic TEP herniorrhaphy by a single surgeon between March 2009 and March 2011. Patients with recurrent hernia were excluded because of additional operating time for dissection due to severe adhesion.

Surgical technique

Under the general anesthesia, the patient was placed on supine position. A vertical skin incision was made about 15 mm in length just below the umbilicus. The subcutaneous fat tissue was bluntly dissected apart using electrocautery. According to the direction of hernia, a vertical incision was done to the lateral portion of the linea alba. After exposure of rectus muscle, blunt dissection was continued between rectus muscle and posterior rectus

sheath using Kelly clamp. And the distension balloon was inflated using Spacemaker (Autosuture, Norwalk, CT, USA). After removing balloon, CO₂ gas was inflated at 10 to 12 mmHg pressure. The 0 degree videoscope was introduced into the port and advanced into the pre-peritoneal space. One trocar was placed above the pubic symphysis. Another trocar was located between the camera port and suprapubic port. The inferior epigastric vessels are identified along the lower portion of the rectus muscle and retracted anteriorly. Cooper’s ligament must be cleared from the pubic symphysis medially to the level of the external iliac vein. The iliopubic tract is also identified. Care must be taken to avoid injury to the femoral branch of the genitofemoral nerve and the lateral femoral cutaneous nerve, which are located lateral to and below the iliopubic tract. Lateral dissection is carried out to the anterior superior iliac spine. The gonadal vessel and the vas deference were parietalized in male patient. After full dissection of pre-peritoneal space, herniated sac was reduced using forcep. The Parietex mesh (Sofradim, Formans, France) was inserted through the camera port. It was positioned on anterior abdominal wall covering Hesselbach triangle, internal inguinal ring, and the medial portion of external iliac vein. It was secured to pubic tubercle with Tacker (Autosuture) in all patients.

Statistical analysis

The observed differences were subjected to statistical analysis using SPSS ver. 17.0 (SPSS Inc., Chigago, IL, USA) (Fisher’s exact tests and χ^2 -test). Statistical significance level was set at P-values < 0.05.

RESULTS

Clinical characteristics

The clinical characteristics of total 90 patients underwent laparoscopic TEP herniorrhaphy are presented in Table 1. The first case up to 30th cases was categorized into the learning period group, and after 30th case was called, the experienced period group. The mean age was 53.8 ± 18.5 years (range, 19 to 78 years) for the learning period group and 53.1 ± 18.1 years (range, 14 to 82 years) for the

experienced period group. The male to female sex ratio was 29:1 for the learning period group and 57:3 for the experienced period group. There were no statistical significant differences between two groups in age, sex, direction and type of hernia.

Moving average curve

As designate in Fig. 1, the simple moving average of the study group converted into the graph. The X axis displays the case which means a group of 10 patients consequently, and Y axis represents the mean operating time which was a group of 10 cases. Mean operating time of each set of 10 cases was decreased continuously. The operating time gradually stabilized after 20 cases and show a dramatic decrease after 30 cases. Additionally, more stable curve was drawn after 40 cases. And considering the operating time as a variable, the statistically significance shows after 30

cases (P = 0.015).

Comparison of operative outcomes

Table 2 lists some of the measured parameters between the two groups. The mean operating time of learning period group was 66.3 ± 26.2 minutes (range, 25 to 130 minutes), experienced period group was 52.8 ± 18.3 minutes (range, 30 to 110 minutes), which remained steady for the next operations. Reduction in operating time was significant between two groups (P = 0.015). The pain killer for postoperative pain from operation to discharge was used to pethidine or nonsteroidal anti-inflammatory drug. The frequency of pain killer use was 0.5 times in the learning period group, and 0.4 times in the experienced period group, showing no significant difference (P = 0.406). The duration of hospital stay was 2.7 days and 2.4 days, respectively, also showing no significant difference (P = 0.497).

Table 1. Clinical characteristics of TEP patients

Characteristic	Learning period (n ≤ 30)	Experienced period (n > 30)	P-value
Age (yr)	53.8 ± 18.5	53.1 ± 18.1	0.864
Sex (M:F)	29:1	57:3	1.0
Body mass index (kg/m ²)	23.1 ± 2.3	23.0 ± 2.2	0.893
Direction of hernia			0.075
Unilateral	26 (86.7)	59 (98.3)	
Bilateral	4 (13.3)	1 (1.7)	
Type of hernia			0.352
Direct	7 (23.3)	13 (21.7)	
Indirect	22 (73.3)	47 (78.3)	
Combined	1 (3.4)	0 (0)	

Values are presented as mean ± SD or number (%).

Postoperative complications

The complications after surgery included 4 cases of hematoma, 1 case of scrotal swelling and 1 case of mesh in-

Table 2. Comparison of operative outcomes

	Learning period (n ≤ 30)	Experienced period (n > 30)	P-value
Operation time (min), mean ± SD	66.3 ± 26.2	52.8 ± 18.3	0.015
Hospital stay (day)	2.7	2.4	0.406
No. of pain control	0.5	0.4	0.497

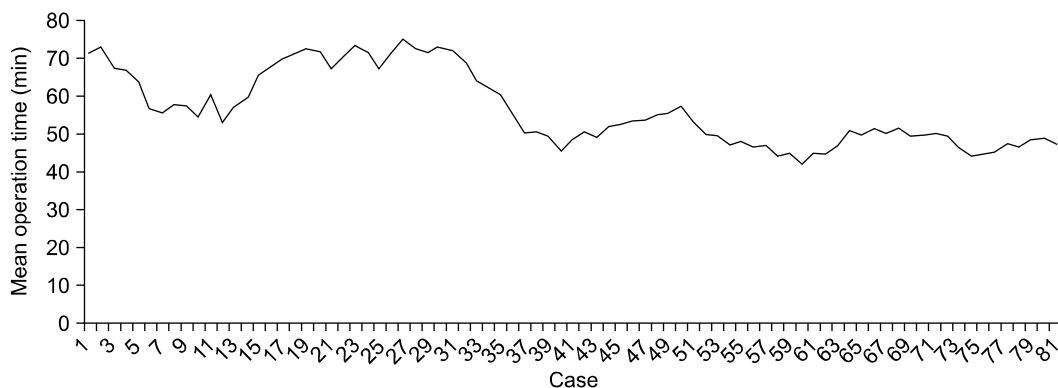


Fig. 1. Moving average curve for laparoscopic totally extraperitoneal herniorrhaphy.

Table 3. Postoperative complications

	Learning period (n ≤ 30)	Experienced period (n > 30)	P-value
Bleeding	0	0	
Hematoma	4	4	
Scrotal swelling	1	1	
Mesh infection	1	0	
Urinary retention	0	0	
Total (%)	6 (20)	5 (8.3)	0.170

fection in the learning period group. On the other hand, 4 cases of hematoma and 1 case of scrotal swelling were found in the experienced period group (Table 3).

Therefore, the complication rate was 20% in learning period group and 8.3% in experienced period group. There was no significant difference between the two groups ($P = 0.170$).

DISCUSSION

Nowadays, the laparoscopic and endoscopic surgery have been widely performed in each specialized surgery and treatment, and it so called, the modern days of the minimally invasive surgery. It display many difference comparing to the conventional surgery in aspect of the limitation of the surgical field view and instrumentation. And in other studies, the learning curve of the laparoscopic surgery was influenced by experiences of surgeon, surgical assistants, environments of operating room, and anesthesiologist and specialized nurse. Therefore, there were many difficulties in the laparoscopic surgery even if experienced surgeons who have many cases in the conventional open surgery.

The concepts of the learning curve are to quantify the degrees of each individual adaptation and to study of the process of adapting the laparoscopic surgery in a real time which actually become the barrier to start the minimally invasive surgery for the laparoscopic surgery. The studies of the learning curve have been done continuously, and the time of minimizing the postoperative complication or of stabilizing the operation time was used to define the learning curve [7].

In laparoscopic cholecystectomy, the learning curve

was defined as 20 cases or more when the point of the postoperative complication and operating time were stabilized. And in laparoscopic colectomy, the learning curve was set from 30 to 70 cases of the field experience by using operating time and postoperative complications, and open conversion [8,9]. And the learning curve of the laparoscopy assisted distal gastrectomy was approximately 60 cases by using the operating time. Choi et al. [10] reported the learning curve for laparoscopic TEP repair was 60 cases for a beginner surgeon.

There is a general consideration that a laparoscopic approach to inguinal hernia repair has better long term quality of life outcomes when compared to an open modified Lichtenstein repair [1]. Based on this concepts, the laparoscopic TEP herniorrhaphy was widely used [11].

It is a difficult task to define the precise learning curve by the decreasing point of postoperative complications and stabilizing point of operating time. In this study, as for the mean operating time, there was a statistically significant difference between the initial 30 cases and the subsequent 60 cases. The postoperative complications decreased from initial 30 cases. There were hematoma and scrotal swelling as the complications which were treated by the conservative cares. The postoperative complications can be decreased by surgeons and assistants adapting the procedures and developing the operating procedures.

Our suggestion of approximately 30 cases to become proficient TEP herniorrhaphy is just one surgeon's initial experience and this represents a self-taught technique. The learning curve will be shortened if there is a formal training course, close intra-operative supervision by specialist practitioners is available and the surgeon receives assistance from other well-trained staff [11]. And the study did not demonstrate reduction in postoperative complications and mean hospital stay with experience despite significant reduction in operating time.

In conclusion, we suggest that the number of patients needed to learning curve for laparoscopic TEP herniorrhaphy would be 30 cases. The operating time for laparoscopic TEP herniorrhaphy stabilize after 40 cases in moving average analysis. Therefore, laparoscopic TEP herniorrhaphy can be useful surgical procedures if the learning

curve of was overcome.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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