

# Learning Curve in Laparoscopic Inguinal Hernia Repair

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## ABSTRACT

**Background:** There are two standardized techniques for the laparoendoscopic repair of inguinal hernia, i.e., transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP); however, both are associated with a steep learning curve. The objective of the present study was to define the learning curve of a laparoendoscopic inguinal hernia repair for both TEP repair and TAPP repair.

**Material and methods:** In this prospective study, 85 patients with inguinal hernia posted for laparoendoscopic inguinal hernia repair using either TEP or TAPP were included to assess the learning curve. The learning curve was assessed for junior surgeon (otherwise experienced laparoscopic surgeon not performing laparoendoscopic groin hernia repair) under the direct supervision of senior surgeon (regularly performing laparoendoscopic groin hernia repair). The study period was between January 2018 and June 2019. A comparison was done based on patient demographics, details of operative procedure [TEP or TAPP, operative time, intraoperative difficulty, peritoneal laceration (TEP), vascular injury, conversion from TEP to TAPP, and/or open hernia repair] postoperative hospital stay, intraoperative complications, conversion rate, hospital stay in days, and postoperative complications.

**Results:** Out of 85, 50 patients were operated by the senior surgeon (TAPP was done in 38 cases and TEP was done in 12) and 35 by the junior surgeon (TAPP was done in 14 cases and TEP in 20 and 1 case, i.e., 1.2% was converted from laparoscopic to open). There were 103 groin hernias in 85 patients in the study. Indirect, direct, and combined hernias were present in 39, 28, and 36, respectively. In our study, there was less prevalence of direct hernia, i.e., 32.8% out of which 38 and 62% were operated by the senior and junior surgeons, respectively, whereas 45.6% were indirect hernia out of which 40 and 60% were operated by the senior and junior surgeons, that shows its high prevalence. 17.6%, i.e., 15 cases were found to be bilateral hernia out of which 73.33% were operated by the senior surgeon while 82.4%, i.e., 70 cases were unilateral hernia out of which 60% were operated by the junior surgeon, statistically not significant ( $p = 0.44$ ). The patients operated by the senior surgeon had higher mean age, i.e.,  $53 \pm 17.43$  years as compared to the junior surgeon, i.e.,  $46 \pm 14.22$  years ( $p$  value = 0.043) with statistically significant. Mean operating time by the senior surgeon was  $49 \pm 4.63$  minutes, and  $62 \pm 4.20$  minutes for the junior surgeon with a  $p$  value of 0.0005, statistically highly significant. 25.33% of patients had intraoperative complications and 24.13% of patients had a peritoneal injury. The surgeries done by the junior surgeon had 30% of peritoneal injury while it was 21.05% for the senior surgeon in the TEP procedure, statistically not significant ( $p = 0.56$ ). Twenty percent of patients had postoperative complications out of which urinary retention was maximum, i.e., in 8 (9.4%) statistically insignificant with  $p = 0.71$ .

**Conclusion:** The junior surgeon in the present study was highly experienced and accomplished in laparoscopic surgery with over 15 years of experience but not performing laparoendoscopic groin hernia repair; that seems to be the reason for a fewer number of procedures (8 for TAPP and 9 for TEP) required to overcome the learning curve. Therefore, surgeons with excellent laparoscopic skills need a shorter learning curve as compared to the beginner in laparoscopic surgery, when it comes to laparoendoscopic groin hernia repair.

**Keywords:** Laparoendoscopic, Learning curve, totally extraperitoneal/transabdominal preperitoneal repair.

*Journal of Mahatma Gandhi University of Medical Sciences & Technology* (2021): 10.5005/jp-journals-10057-0146

## INTRODUCTION

A hernia, an abnormal protrusion of an organ or tissue through a defect in its surrounding wall, is a very common surgical problem.<sup>1</sup> Various sites of the body are vulnerable to the occurrence of hernia, but the abdominal wall particularly the inguinal region is the most commonly involved region.<sup>2</sup> Approximately 70% (75%) of all hernias are usually groin hernias, among which 95% are inguinal region hernias and the remainder being femoral canal defects. Inguinal hernias being very common in men than in women can be either indirect or direct.<sup>3,4</sup> The aims of successful hernia repair include achieving an effective repair with the lowest possible recurrence rate, minimal pre and postoperative complications, rapid return to normal work, and performing a cost-effective procedure. To achieve these goals, various methods of repair have been employed which have progressed from open repair to various laparoscopic approaches.<sup>5</sup>

There are two standardized endoscopic (laparoscopic) techniques of groin hernia repair—totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP). Totally extraperitoneal and TAPP both have gained popularity in the recent two decades

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**How to cite this article:** Maheshwari S, Sharma BK, Misra MC. Learning Curve in Laparoscopic Inguinal Hernia Repair. *J Mahatma Gandhi Univ Med Sci Tech* 2021;6(2):48–52.

**Source of support:** Nil

**Conflict of interest:** None

since the first introduction in 1992 by Dulucq.<sup>6</sup> This offers a hernia repair of minimal incisions with a more favorable postoperative course including a quick return to work and less pain especially

more pronounced in bilateral inguinal hernia. However, this hernia repair technique requires specialized anatomical knowledge, a long learning curve, two-hand manipulation for reduction of the hernia sac, and mesh placement within a limited working space. Therefore, acceptance and implementation of the laparoscopic inguinal hernia technique have been slow compared with the adoption of the other minimally invasive procedures such as cholecystectomy.<sup>7,8</sup> Currently, laparoscopic herniorrhaphy accounts for 15–20% of hernia operations in the USA and around the world.<sup>7</sup> There have been several attempts to define the learning curve in laparoscopic groin hernia repair. It has been described in a few studies to be ranging from 10 to 60 cases in various studies.<sup>9–11</sup> This prospective study is being designed with the primary objective to assess the learning curve of laparoscopic groin hernia repair and to predict the number of cases required for a surgeon to become proficient in both the TEP and TAPP techniques of laparoscopic groin hernia repair.

## MATERIALS AND METHODS

This study was conducted in unit-I, department of general surgery, Mahatma Gandhi Medical College and Hospital, focused on comparing two surgeons prospectively performing laparoscopic inguinal hernia repair and to know about the learning curve. The junior consultant has 22 years of experience in laparoscopic surgery. He had assisted the senior surgeon in eight cases as a first assistant (camera assistant). The senior surgeon has been proficient at doing both TAPP and TEP and had been performing laparoscopic surgery for the past 28 years. The junior surgeon learned both the procedures simultaneously and performed laparoscopic inguinal hernia repair (TEP or TAPP) under the direct supervision of the senior surgeon.

Patients with primary/recurrent, unilateral/bilateral uncomplicated inguinal hernia from January 2018 to June 2019 were included in this study. Patients with incarcerated, irreducible, or strangulated hernias or who were unfit for general anesthesia were excluded from the study. Written and informed consent of the patients were obtained from all participants before enrolment into the study.

The demographic profile, intraoperative variables, and postoperative complications were recorded on a prestructured proforma. All the data were entered prospectively in a computerized database.

Comparing the learning curve of laparoscopic inguinal hernia repair between the senior and junior surgeons on the following parameters:

- Overall ease and/or difficulty of creation of extraperitoneal space in TEP and TAPP.
- Difference in handling direct vs indirect sac.
- Difference between small indirect vs large sac.
- Separation of the sac with cord structures.
- Dissection of the peritoneum from the cord structures (parietalization).
- Delineation of anatomy—satisfactory vs unsatisfactory.
- Creation of extraperitoneal space—adequate vs inadequate.
- Mesh placement, orientation, and fixation—satisfactory vs unsatisfactory.
- Blood loss.
- Difficulty of procedure as described by the trainee surgeon.
- Conversion.
- Operative time.

- Intraoperative complications.
- Postoperative complications.

## Statistical Analysis

The collected data were analyzed with IBM.SPSS statistics software 23.0 Version. For learning curve analysis, the time series analysis using the moving average method was applied to compare the operating time of junior surgeon with the standard meantime of the senior surgeon keeping as a reference standard.

## OBSERVATION AND RESULTS

From January 2018 to June 2019, 85 patients were operated on for laparoscopic inguinal hernia repair. Out of 85, 50 patients were operated by the senior surgeon (TAPP was done in 38 cases and TEP was done in 12) and 35 by the junior surgeon (TAPP was done in 14 cases and TEP in 20 and 1 case, i.e., 1.2% was converted from laparoscopic to open).

There were 103 groin hernias in 85 patients who were operated on in the study. Indirect, direct, and combined hernias were present in 39, 28, and 36, respectively.

In our study, there was less prevalence of direct hernia, i.e., 32.8% out of which 38 and 62% were operated by the senior and junior surgeons, respectively, whereas 45.6% were indirect hernia out of which 40% and 60% were operated by the senior and junior surgeons, that shows its high prevalence.

17.6%, i.e., 15 cases were found to be bilateral hernias out of which 73.33% were operated by the senior surgeon while 82.4%, i.e., 70 cases were unilateral hernias out of which 60% were operated by the junior surgeon, statistically not significant ( $p = 0.44$ ).

The patients operated by the senior surgeon had a higher mean age, i.e.,  $53 \pm 17.43$  years as compared to the patients operated by the junior surgeon, i.e.,  $46 \pm 14.22$  years ( $p$  value = 0.043) with statistically significant.

Mean operating time by the senior surgeon was  $49 \pm 4.63$  minutes, and  $62 \pm 4.20$  minutes for the junior surgeon with a  $p$  value of 0.0005, which was statistically highly significant ( $p < 0.01$ ).

In this study, 25.33% of patients had intraoperative complications and 24.13% of patients had a peritoneal injury. The surgeries done by the junior surgeon had 30% of peritoneal injury while it was 21.05% for the senior surgeon in TEP procedure. The incidence of peritoneal tear was higher in cases performed by the junior surgeon, but it was statistically not significant ( $p = 0.56$ ).

Twenty percent of patients had postoperative complications out of which urinary retention was maximum, i.e., in 8 (9.4%) with a  $p$  value of 0.71 which was statistically insignificant. In a case which was done by TAPP by the junior surgeon, on post-op day 2 patient went into intestinal obstruction, and on re-exploration intestinal loops were obstructed in the rent of peritoneum which was repaired laparoscopically.

In our study, the mean days of discharge of patients whose surgery was done by the junior surgeon are 2.66 days, and for the senior surgeon, it is 2 days (Table 1).

Postoperative follow-up:-

Data	Senior surgeon	Junior surgeon	<i>p</i> value
Urinary retention	4 (8.0%)	4 (11.4%)	0.712
Seroma/hematoma	3 (6.0%)	2 (5.7%)	1.000
Cord edema	2 (4.0%)	1 (2.9%)	1.000
Intestinal obstruction	0 (0.0%)	1 (2.9%)	0.412

**Table 1:** Demographic profile and intraoperative variables

S. no.	Data	Senior surgeon (n = 50)	Junior surgeon (n = 35)	p value
1	Mean age (years)	53 ± 17.43	46 ± 14.22	0.043
2	Type of hernia			
	Direct	19 (62%)	9 (38%)	0.259
	Indirect	18 (40%)	21 (60%)	
	Bilateral	11 (73.33%)	4 (26.66%)	
3	Type of repair			
	TEP	38 (76.0%)	20 (57.10%)	0.121
	TAPP	12 (24.0%)	14 (40%)	
4	Conversions			
	Conversion to open	0	1 (2.90%)	0.12
5	Operating time			
	Mean operating time (in minutes)	49 ± 4.63	62 ± 4.20	0.0005
	TEP	47 ± 3.2	58 ± 3.10	
	TAPP	51 ± 6.1	66 ± 5.30	
6	Intraoperative complications			
	Peritoneal tear	8 (21.05%)	6 (30%)	0.566
	Vascular injury	0	1 (2.90%)	0.412
7	Mesh placement (satisfactory or unsatisfactory)	Satisfactory	Satisfactory	
8	Creation of extraperitoneal space (adequate or inadequate)	Adequate	Adequate	

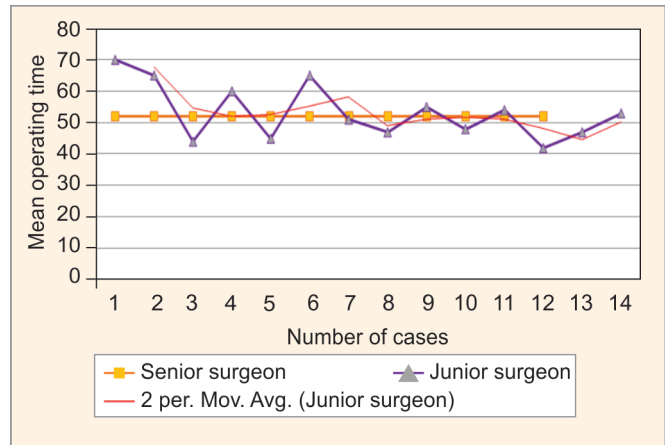
Surgeon	Data	Very difficult	Difficult	Neutral	Easy	Very easy
Senior	TEP/TAPP cases	0/0	0/0	0/0	15/4	13/8
Junior	TEP/TAPP cases	0/1	3/1	8/4	4/6	5/3

Using the moving average method, it was found that a junior consultant who is doing laparoscopic procedures needs a minimum of eight laparoscopic hernia repairs to reach at par the operating time for the experienced surgeon. For TEP repair, the number of cases was 9; and for TAPP repair, this number was 8 (Figs 1 and 2). The operating time had a significant difference (*p* value = 0.0005).

**DISCUSSION**

The present study was carried out on 85 patients admitted in the Unit-I department of general surgery, Mahatma Gandhi Medical College and Hospital with a diagnosis of inguinal hernia from January 2018 to June 2019. This study was designed to assess the learning curve and to predict the number of cases required for a surgeon (otherwise experienced in laparoscopic surgery) to become proficient in laparoscopic groin hernia repair both for TEP and TAPP, by comparing two laparoscopic surgeons.

Inguinal hernia repair has an extensive history and refinements with time have to lead to laparoscopic tension-free techniques that have proven very successful.<sup>12</sup> Laparoscopic hernia repair is not considered an easy technique for surgeons, especially for beginners, because of the anatomical complexity and associated steep learning curve.



**Fig. 1:** Moving average graph to show the comparison of mean operating time between the two groups in TAPP repair

The learning curve has been defined as the number of operations required for stabilization of the duration of surgery and complication rates.

The learning curve comprises three components: the starting point, the slope of the curve, and the plateau of the curve.

Laparoscopic inguinal hernia repair has the following advantages:<sup>13</sup> less postoperative discomfort, reduced recovery time, allowing an earlier return to full activity, easier repair of a recurrent hernia, the ability to treat bilateral hernias simultaneously, the performance of a simultaneous diagnostic laparoscopy (TAPP), the highest possible ligation of the hernia sac, and an improved cosmesis.<sup>12,14-17</sup>

In our study, we assessed the learning curve in terms of different parameters.

**Demographic Data**

In our study, the majority of the patient were distributed in the age group of above 60, 51-60, and 41-50 years, i.e., 27.1, 22.4, and 22.4%, and only 2.4% of patients were <20 years of age, thereby showing age dependency.

The patients operated by the senior surgeon had higher mean age, i.e., 53 ± 17.43 years as compared to the patients operated by the junior surgeon, i.e., 46 ± 14.22 years (*p* value = 0.043). Similar results were found in Bansal et al.,<sup>18</sup> in which, mean age was 50.9 years for the senior surgeon and 42.76 years for the junior surgeon with *p* = 0.003.

In the present study, the majority of the patients were male, i.e., 98.8%. Malagoni et al.<sup>2</sup> and reported the prevalence of hernia to be more in males than females by a ratio of 7:1 and men are 25 times more likely to have inguinal hernia than women.

Smoking had a strong contribution as a predisposing factor, i.e., 34.1%, followed by chronic cough (22.4%), prostatism (18.8%), constipation (7.1%), and previous surgery (3.5%).

In our study, it was found out that there was less prevalence of direct hernia in our study population, i.e., 32.8% out of which 38% were operated by the senior surgeon, 45.6% were indirect hernia out of which 60% were operated by the junior surgeon, only one case had left direct + indirect hernia, which was operated by the senior surgeon while two cases have right direct + indirect hernia, in which one was operated by the senior surgeon and one was operated by the junior surgeon.



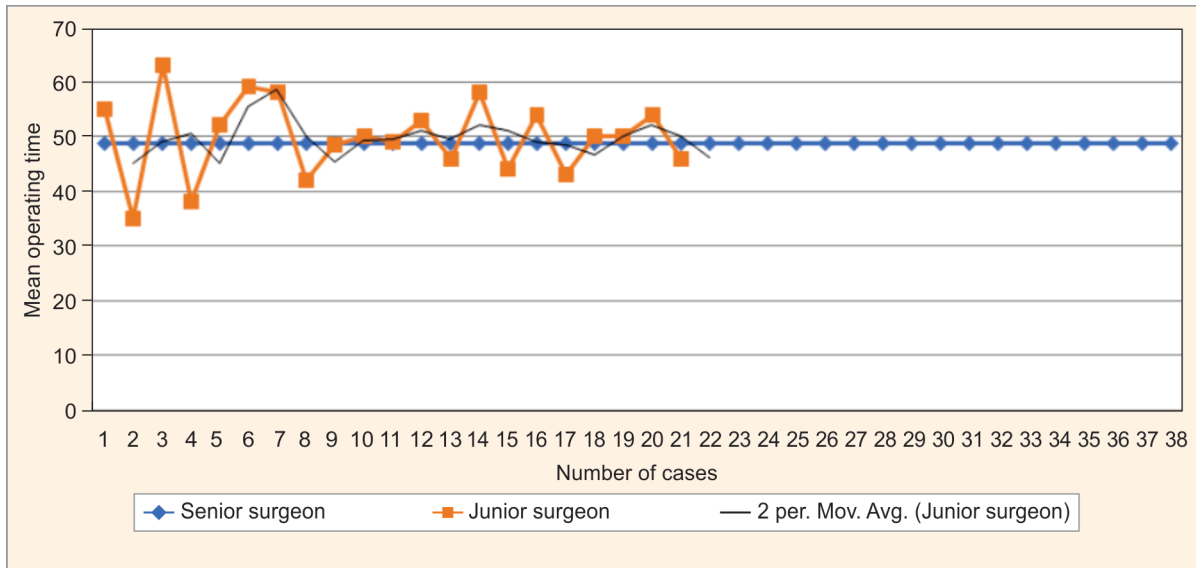


Fig. 2: Moving average graph to show the comparison of mean operating time between the two groups in TEP repair

The prevalence of direct and indirect hernia was in line with, Schouten et al.,<sup>19</sup> which concluded that 65.9% were indirect hernias of total and 30.9% were direct hernia.

In this study, we found out that 17.6% were bilateral hernias, 32.9% were unilateral left-sided, and 49.4% were unilateral right-sided. Similarly, in Mihăileanu et al.,<sup>20</sup> 15% were bilateral inguinal hernia, 35% with unilateral left-sided, 50% with a unilateral right-sided hernia. On the contrary, in Misra et al.,<sup>21</sup> 54% were bilateral, 29% were unilateral right, and 17% were unilateral left hernias.

### Duration of Surgery

In our study, the mean operating time by the senior surgeon was  $49 \pm 4.63$  minutes, and  $62 \pm 4.20$  minutes for the junior surgeon with a  $p$  value of 0.0005. Similar results were seen in Bökeler et al., 2013.<sup>22</sup> The young trainees needed significantly more operating time for TAPP—a mean of 59 vs 46 minutes ( $p$  0.001) in the expert group.

### Intraoperative Complications

In this study, 25.33% of patients had intraoperative complications and 24.13% of patients had a peritoneal injury. The surgeries done by the junior surgeon had 30% of peritoneal injury while it was 21.05% for the senior surgeon in TEP procedure. The incidence of peritoneal tear was higher in cases performed by the junior surgeon, but it was statistically not significant ( $p = 0.56$ ). These peritoneal injuries occurred in cases who had large direct or indirect hernia sac which was densely adherent to the cord structure and dissection was difficult and during separation there was peritoneal breach, resulting in peritoneal injuries which were managed either by putting Veress needle intraperitoneal at the palmar point or there was a minor leak for which no treatment or conversion was required. One patient had a vascular injury which was then converted to open, i.e., 1.2% of total cases. 2.9% of all the cases done by the junior surgeon had a vascular injury which was managed conservatively without converting the procedure, whereas no vascular injuries were noted in surgeries done by the senior surgeon. In line with this, in Bansal et al.,<sup>18</sup> 25.4% of total surgeries performed by the junior surgeon had a peritoneal injury which is more when compared with the surgeries were performed

by the senior surgeon (15.2% of total), no conversions were noted in this study. On the contrary, according to Misra et al.,<sup>21</sup> in TEP procedure, more vascular injuries were noted, out of 298 TEP procedures, 26 were converted to TAPP and 5 were converted to open.

In Hasbahceci et al.,<sup>23</sup> 33.3% was the prevalence of peritoneal injury in TEP procedure and 7 cases out of 42 cases, i.e., 33.3% were converted from laparoscopic surgery to open.

### Post-op Complications

In our study, a total of 20% of postoperative complications were noted. Out of which eight (9.4%) cases had urinary retention for which patients were catheterized and removed when the retention was relieved, on follow-up, there was no complaint of burning micturition or urinary tract infection, while in various studies like Kim and Hur,<sup>24</sup> Kwon et al.,<sup>25</sup> Mathur and Lin,<sup>26</sup> and Vărcuș et al.,<sup>27</sup> it was found to be ranging from 3.2 to 22%.

In our study, five (5.9%) cases had seroma formation, while in various studies, like Kim and Hur,<sup>24</sup> Kwon et al.,<sup>25</sup> Mathur and Lin,<sup>26</sup> and Vărcuș et al.,<sup>27</sup> it was reported from 2.1 to 17%.

In our study, 4 and 2.9% of cases had cord edema while in a study done by Bansal et al.,<sup>18</sup> 15.9 and 14.3% of cases had cord edema which was done by the senior and junior surgeons, respectively.

In this study, 1.2% had intestinal obstruction, i.e., one case which was done by TAPP, on postoperative day 2 patient went into intestinal obstruction, and on re-exploration intestinal loops were obstruct in the rent of peritoneum which was repaired laparoscopically.

In our study, there was no recurrence was found, while in a study done by Kim and Hur,<sup>24</sup> it was a minimum of 0.5% and in Mathur and Lin<sup>26</sup> study, it was 3%.

There was no significant difference in any of the postoperative complications in the two groups.

### Duration of Hospital Stay

In our study, the mean days of discharge of patients whose surgery was done by the junior surgeon are 2.66 days, and for the senior



surgeon, it is 2 days. Allowed oral intake with a mean average of 1.08 days for the junior surgeon and 1.04 days for the senior surgeon.

Normal diet was started for a senior surgeon with a mean of 1.5 days and junior surgeon 2.08 days.

Compared with other studies, Vărcuş et al.<sup>27</sup> have an average hospital stay of 2 days, Kwon et al.<sup>25</sup> have an average hospital stay of 2.92 days.

### Learning Curve

In our study, by using the moving average method, it was found that the junior surgeon needed a minimum of eight TAPP cases to reach at par operating time for the experienced surgeon and TEP repair, the number of cases was 9. The operating time for the first eight cases had a significant difference with the *p* value of 0.0005. While in Bansal et al.<sup>18</sup> it was found that the learning curve for the junior surgeon was 13 cases for TAPP repair and 14 cases for TEP repair.

In the study done by Lim et al.,<sup>28</sup> Kwon et al.,<sup>25</sup> and Choi et al.,<sup>8</sup> learning curve for TEP repair was found to be 30, 37, and 60 cases.

The junior surgeon in the present study was highly experienced in laparoscopic surgery with over 15 years of experience, which seems to be the reason for the fewer number of procedures (8 for TAPP and 9 for TEP) required to overcome the learning curve. Therefore, the surgeons with excellent laparoscopic skills need a shorter learning curve as compared to the beginner in laparoscopic surgery.

### CONCLUSION

The junior surgeon in the present study was highly experienced and accomplished in laparoscopic surgery with over 15 years of experience but not performing laparoendoscopic groin hernia repair; that seems to be the reason for a fewer number of procedures (8 for TAPP and 9 for TEP) required to overcome the learning curve. Therefore, surgeons with excellent laparoscopic skills need a shorter learning curve as compared to the beginner in laparoscopic surgery, when it comes to laparoendoscopic groin hernia repair.

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