ORIGINAL RESEARCH

Learning curve for Lichtenstein hernioplasty

Mark Wiese[1]
Thomas Kaufmann[2]
Jürg Metzger[3]
Guido Schüpfer[4]
Philipp Honigmann[1]

[1]Surgical Department, [2]Quality and
Risk Management, [3]Visceral Surgery,
[4]Anaesthesiological Department,
Cantonal Hospital Lucerne, Lucerne,
Switzerland

Correspondence: Philipp Honigmann
Surgical Department Cantonal
Hospital Lucerne, Spitalstrasse,
6000 Lucerne 16, Switzerland
Tel +41 41 205 1111
Email honeyman@bluewin.ch

Purpose: In surgery the term 'learning curve' is often used to describe the phenomenon of acquiring the surgical skills to perform a specific operation safely, sufficiently and effectively without providing the exact amount of procedures needed. The learning curve in the field of open inguinal hernia repair using an open mesh technique has not been evaluated so far. The purpose of this study is to specify exactly how many procedures are truly necessary to perform this kind of surgical procedure safely. The result of this study is hoped to impact the education of young surgeons, namely that a specific target number of procedures needed is considered when referring to the learning curve.

Methods: Residents participating in this study were in their first 2 years and had assisted in Lichtenstein procedures before performing their first operation. The cut to suture time was recorded and a logarithmic fit model was used. The time difference between two surgical cases with regard for the influence on performance was also assessed.

Results: Four hundred seventy-one patients with 489 primary uni- and bilateral inguinal hernias and 36 first year residents naïve for this procedure were included. The estimated cut to suture time reached 69 minutes (median) after 40 procedures. Nine mild adverse events occurred.

Conclusion: Based on our data, we concluded that performing open hernioplasty under supervision is an effective and safe training method for young residents and it is a helpful method to differentiate between learning and nonlearning residents.

Keywords: inguinal hernia, hernioplasty, Lichtenstein, learning curve

Introduction

Increasing performance through learning and repeating is well known. The repetition of a special task over a period of time leads to improvement of the results and shortens the time used to complete the task. The performance gained depending on the experience is reflected by a learning curve.

The learning curve was first introduced in 1885 by Ebbinghaus in the field of cognitive psychology and later to the aircraft industry by Wright et al[1] in 1936. The term had a renaissance in 1970 in health care and gained popularity in the 1980s, especially in the field of minimal invasive/access surgery. The term itself is widely used in literature to describe the phenomenon itself to acquire higher skills performing surgical procedures, but often without providing clear data.

When laparoscopic hernia surgery became popular, the learning curve for this kind of hernia repair was a matter of debate.[2] The learning curve for open procedures has never been in focus so far. In the field of open hernia surgery, there is only rare data

regarding a learning curve as well as the amount of performed open procedures to gain good and comparable results.

Even in the era of laparoscopic hernia surgery, open inguinal hernia repair remains the standard procedure for primary uni- and even bilateral hernias in men.[3,4] Since the introduction of meshes in this field, the Lichtenstein procedure has reached wide acceptance and proved to achieve very convincing results.[5,6]

Open hernioplasty is often performed by residents in their first year(s) of surgical training. We choose the hernioplasty of Lichtenstein[5] to develop the learning curve and a minimal case-load for a safe and sufficient procedure among the residents as this procedure is a standardized and a safe intervention.

Materials and methods

We included 471 consecutive patients with primary uni- and bilateral inguinal hernias between 20 and 97 years old (SD 16) (Table 1). Thirty-six residents in their first 2 years were included. It was required that these residents had to assist 5–10 Lichtenstein procedures before performing their first hernio-plasty. The operations were supervised by an experienced certified general surgeon at our university-associated hospital. All of the residents had to perform the entire procedure. Either spinal or general anaesthesia were used.

In contrast to Pandit et al[7] who recorded the time between arrival of the patient in the anesthetic room and the time of arrival of the patient in the recovery room as 'duration of operation', we recorded the pure 'operation time' or cut to suture time (CST) as used, ie, by Liem et al[8] defined as time from first incision to last suture.

The operation times (in our case CST) for hernioplasty in a consecutive manner for each resident, the case-load, and peri- and postoperative complications are reflective of the learning curve according to Wojtyczka.[11] Although differences in assigned cases and supervision may influence performance. A logarithmic fit model based on a plot of a CST versus procedure number was used. In this model a negative coefficient is indicating learning. The time difference between two surgical cases with regard to the influence on

Table 1 Patient data

	Male	Female
N	436	35
Age (median)	57	68
Cut to suture – time (mins median)	76	60
ASA I	208	10
ASA II	186	19
ASA III	42	6

Abbreviations: ASA, American Society of Anesthesiologists.

performance was also assessed. All data was recorded in the anesthesia database record. A P-value of 0.05 was considered as statistical significant.

Surgical technique (Lichtenstein)

After the preparation and resection of the hernia, the apeunorosis of the external oblique muscle is blunt dissected from the internal oblique muscle to fit the net. A composite polyglactin 910-poly-propylene mesh (Vypro II; Ethicon, Somerville, NJ, USA) 10×15 cm is cut into size. In male patients a lateral cut (1/3 caudal flat, 2/3 cranial flap) is necessary to fit the net around the spermatic cord. The caudal border is fixed with a running suture onto the lower part of the inguinal ligament using Prolene® 2-0.

The cranial lateral flap is placed around the spermatic cord constructing a new internal inguinal ring and fixed on top of the caudal flap of the net. All parts can be fixed together onto the lower section of the inguinal ligament with interrupted sutures using Prolene® 2-0. The medial and cranial border of the net is fixed to the internal oblique muscle with 2 to 3 interrupted sutures using Prolene® 2-0. In female patients the ligamentum teres uteri is resected medial and lateral above the internal inguinal ring and fixed with a Vicryl® 2-0 interrupted suture respectively. The apeunorosis of the external oblique muscle is closed with a running PDS® 2-0 suture. The sub-cutaneous tissue is closed using a running suture Vicryl® 2-0 and the skin is closed using a intracutaneous self-resorbable running suture Monocryl® 4-0.

Results

218 of the patients were classified American Society of Anesthesiologists (ASA) class I, 205 ASA II, and 48 ASA III (Table 1). The distribution between hernia types are shown in Table 2. The average operation time was 77 min (range 15–225, SD 25) and the mean caseload per resident was 11 (range 1–49, SD 12). The correlation between two attempts was statistically significant for all residents and in a linear regression model case duration were statistically significant shorter with increased experience ($P = 0.02$, duration = −0.44 attempt +87.2). Using a logarithmic fit model, 12 of 36 residents improved their per-formance; a negative coefficient in the logarithmic fit model was found and therefore demonstrating a positive learning curve (Figure 1). The residents saved an average 5% of CST

Table 2 Hernia data

N	Tender groin'	Direct	Indirect	Inguinoscrotal	Combined
Unilateral	6	139	207	19	82
Bilateral	2	26	6		2

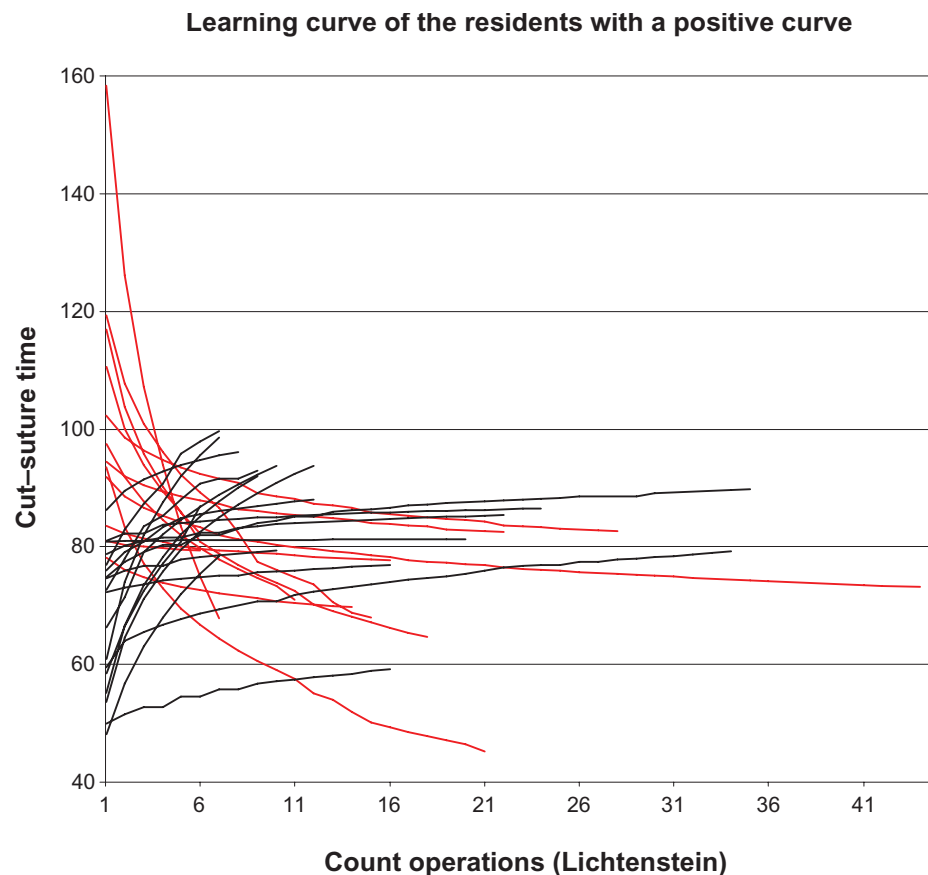**Learning curve of the residents with a positive curve**

Figure 1 Learning curve of the residents – learning (red) and nonlearning (black) residents. X-axis, number of procedures; Y-axis, cut-suture time in minutes.

by doubling the case number. The estimated CST reached 69 minutes after 40 procedures using the model. There was no statistical difference (learning residents: average = 13.95 days, 95% confidence interval [CI]: ± 2.59; not learning residents: average = 16.28, 95% ± CI: ± 2.89) in time difference of days between learning and nonlearning residents for these procedures (median for both groups between two procedures 7 days). Patients were observed until discharge. According to the adverse event reporting of the US Food and Drug Administration (FDA) no severe adverse events occurred during in the study population. We observed 9 mild adverse events: five conservatively treated postoperative hematomas; one hematoma required an additional intervention; one patient needed additional IV pain medication resulting in a prolonged hospitalization of 4 days; and two patients developed a pneumonia postoperatively treated with antibiotics, which made a hospitalization of 8 days necessary.

Discussion

We proved that open hernioplasty still remains one of the best and quick to learn hernia repair procedures for young surgeons with an acceptable complication rate. The CST of 69 min for our tension-free hernioplasties using lightweight

mesh after 40 procedures is within the limits published in the literature. De Turris et al[9] reported operation times between 30 and 130 min for open anterior hernia repair procedures. Liem[10] reported 40 min, Wojtyczka 53.6 min,[11] and Pandit 49 min[7] for open procedure with or without mesh.

In our study the minimal case-load for the Lichtenstein procedure was 40 mins. We proved a faster learning performance during the first cases compared to laparoscopic surgery.[8] Several authors have examined the learning curve for the totally extraperitoneal laparoscopic repair (TEP) repair and found that 80–100 procedures are required for a surgeon to complete the repair in less than 1 hour.[12,13]

Interestingly, the time between two procedures was not relevant for the separation between learning and nonlearning residents. This could be described as the 'bicycle effect'; once understood and learned, the resident will continue to improve. Residents who are unable to anticipate the procedure will continue to perform badly.

The exceptional performing residents reach a phase of well performance. And the worse performing residents are performing better during their learning process. But all of them reach a sort of 'goal, the 69 min as the mean CST.

Based on our data, we can state that performing open hernioplasty under supervision is a reliable and safe training method for young residents and it is a good method to differentiate between learning and nonlearning residents. Since there is no virtual reality (VR) training for open procedures like for hernioplasty, the data is not distorted like those for laparoscopic surgery. Over the last years, VR training before entering the operating theatre became popular in this field. Therefore, the performance for the real procedure is depending on the VR training done beforehand.

Our findings can help to optimize surgical training and its supervision. Objective supervision of the learning performance of surgeons has to become a primary goal in surgical training. It could help to set up a more realistic catalogue of surgical procedures needed during the surgical training to perform them safe and with good results.

We recommend that in the future the use of the term 'learning curve' is always specified by indicating a concrete number of required procedures according to the method used.

Disclosure

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