

THE LEARNING CURVE IN LAPAROSCOPIC INGUINAL HERNIA REPAIR FOR THE COMMUNITY GENERAL SURGEON

Andrus J. Voitk, MD, MSc, PhD

OBJECTIVE: To determine the learning curve (number of operations required) to stabilize operating times and complication rates for a general surgeon doing laparoscopic inguinal hernia repair in a community practice.

DESIGN: A prospective analysis.

SETTING: A 256-bed secondary-care community hospital.

PATIENTS: Ninety-eight consecutive patients booked for elective laparoscopic hernia repair on an outpatient basis.

INTERVENTIONS: Using the transabdominal preperitoneal approach, 100 operations were carried out to repair 138 groins and a total of 164 separate hernial defects.

OUTCOME MEASURES: The number of operations required to decrease operative times and complication rates to a steady level.

RESULTS: There were no deaths. There were 5 conversions and 10 admissions, all occurring between the 1st and 46th operations. Two reoperations for reasons other than recurrence were required between the 45th and 55th operations. There were 24 other complications. Complications and surgical times began to level off after 50 operations. The 1 readmission was after the 42nd operation. There were 4 recurrences (2.9% recurrence rate), 2 in each group of 50 operations. Both groups of 2 recurrences occurred within the first 10 operations involving the use of a new stapler. Twenty-two other patients had open hernia repairs because laparoscopy was unsuitable for them.

CONCLUSION: The learning curve for laparoscopic inguinal hernia repair in the hands of a general surgeon in community practice who is experienced in open herniorrhaphy and laparoscopic cholecystectomy is at least 50 operations.

OBJECTIF : Définir la courbe d'apprentissage (nombre d'interventions nécessaires) pour stabiliser la durée des interventions et les taux de complications dans le cas d'un chirurgien général qui répare des hernies inguinales par laparoscopie dans une pratique communautaire.

CONCEPTION : Analyse prospective.

CONTEXTE : Hôpital communautaire de soins secondaires de 256 lits.

PATIENTS : Quatre-vingt-dix-huit patients consécutifs qui ont subi une intervention élective de réparation d'une hernie par laparoscopie, en service externe.

INTERVENTIONS : On a utilisé l'approche préperitonéale transabdominale pour pratiquer 100 interventions afin de réparer 138 aines et, au total, 164 défauts herniaires distincts.

MESURES DE RÉSULTATS : Nombre d'interventions nécessaires pour ramener la durée des interventions et les taux de complication à un niveau stable.

From the Department of Surgery, The Salvation Army Scarborough Grace Hospital, Scarborough, Ont.

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Correspondence to: Dr. Andrus J. Voitk, The Salvation Army Scarborough Grace Hospital, Suite 1840, 3030 Birchmount Rd., Scarborough, ON M1W 3W3; tel/fax 416 495-7397, minaise@pathcom.com

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RÉSULTATS : Il n'y a eu aucun décès. Il a eu cinq conversions et 10 admissions, toutes entre la première et la 46^e intervention. Il a fallu répéter deux interventions pour des raisons autres qu'une récurrence entre la 45^e et la 55^e intervention. Il y a eu 24 autres complications. Les complications et la durée des interventions chirurgicales ont commencé à se stabiliser après 50 interventions. La seule réadmission s'est produite après la 42^e intervention. Il y a eu quatre récurrences (taux de récurrence de 2,9 %), deux dans chaque groupe de 50 interventions. Les deux groupes de deux récurrences se sont produits au cours des 10 premières interventions pendant lesquelles on a utilisé une nouvelle agrafeuse. Vingt-deux autres patients ont subi des réparations herniaires ouvertes parce que la laparoscopie ne leur convenait pas.

CONCLUSION : La courbe d'apprentissage de la réparation d'une hernie inguinale par laparoscopie réalisée par un chirurgien général en pratique communautaire qui a de l'expérience de la herniorraphie ouverte et de la cholécystectomie par laparoscopie est établie à au moins 50 interventions.

For surgical procedures, the learning curve may be defined by the number of operations required for operating times and complication rates to become stable. Discussions of laparoscopic inguinal hernia repair usually refer to a long learning curve, without specifying the number of procedures. Three surgeons with extensive experience in laparoscopic inguinal hernia repair all estimated the learning curve to be 50 operations (Dr. Myung I.L. Park, Peel Memorial Hospital, Brampton, Ont.; Dr. Lloyd C. Smith, St. Joseph's Health Centre, Toronto, Ont., and Dr. Gary L. Stoik, Toronto East General and Orthopaedic Hospital, Toronto, Ont.: personal communication, 1993), but to date there are no published data confirming the length of the learning curve for this repair. To obtain a more exact measure of the learning curve for this procedure, I analysed my own first 100 consecutive laparoscopic operations for inguinal hernia repair (my practice is not limited to hernia repair or laparoscopy).

METHODS

Patient information was entered prospectively. With the same assistant I carried out 122 consecutive operations for elective hernia repair on 120 patients between March 1992 and May 1996 at the Salvation Army Scarborough Grace Hospital, a 256-bed nonteaching community hospital on the periphery of a major urban centre.

Twenty-two of the patients required open surgery, as they were not suitable for laparoscopy. Follow-up on the remaining 98 patients was carried out at 2 weeks and 3 months postoperatively. All patients were carefully instructed to report any concerns or complications, especially suspicion or confirmation of recurrence, at any time, regardless of whether or where they wished to have a repeat repair done. All patients were booked as outpatients.

A transabdominal approach was used with 2 contralateral working ports. If present, umbilical or epigastric hernias were excised, used for the camera port and repaired on closure. The peritoneum of the inguinal floor was reflected posteriorly, usually incorporating the hernial sac but occasionally leaving behind large indirect sacs. Prolene mesh was fixed to Cooper's ligament, the pubic tubercle and transversalis fascia, covering the inguinal floor and hernial defect, and the peritoneal flap was replaced over the mesh where possible. The endoscopic articulating stapler (Ethicon Endo-Surgery, Cincinnati, Ohio) was used for the first 67 cases, the Auto-Suture Endo Universal 65° rotator (United States Surgical Corporation, Norwalk, Conn.) for the next 26 operations and the Origin tacker (Guidant; Origin Medsystems Inc, Menlo Park, Calif.) for the remaining 7. With the exception of these mesh-fixing devices, all instruments, cannulas and trocars were reusable. Antibiotics were not used, and the bladder was not catheterized.

Observed differences were subjected to statistical analysis using the Student's *t*-test or χ^2 test, and a difference was considered significant if the probability was $\leq 5\%$ that an observation was due to chance.

PATIENTS AND TYPES OF HERNIAS

The patients' ages ranged between 24 and 88 years (average 57 years); 92% were men. The classification of physical status according to the American Society of Anesthesiologists was 37 in class 1, 45 in class 2, and 18 in class 3.

All operations were booked for hernias detected by physical examination; no operations were done for groin pain or cough impulse in the absence of a palpable hernia.

In total, 164 separate hernial defects and 138 groin defects were repaired laparoscopically in 100 operations on 98 patients. Of the groin hernias, 62 were unilateral (right/left 33/29) and 38 were bilateral. Of the patients booked for unilateral hernia repair, 30% were found to have unsuspected contralateral defects (50% of all bilateral hernias were unsuspected). Twenty-one inguinal hernias were pantaloony type; of the remainder, 58% were indirect and 42% direct. There was 1 massive sliding hernia. Four were femoral hernias. Nine patients had associated umbilical hernias and 1 had an epigastric hernia. Eight operations were for the first recurrence, 4

for the second, 2 for the third and 1 for the fourth.

RESULTS

Operating times for the unilateral procedures began to level off after 50 operations, whereas a statistically insignificant decrease continued for bilateral hernias to the end of the study (Table I). Average operating-room time (patient entering the room to patient leaving) was 73 minutes, and average surgery time (skin incision to skin closure) was 52 minutes (unilateral 46 minutes, bilateral 62 minutes). Initially, the operating time was twice the historic time for open hernia repair, but at the end of the study the times for the unilateral procedures had levelled off at 58 minutes (operating time) and 37 minutes (surgical time), which approached the historic times for open repair.

The complication rates fell in an approximately exponential manner, beginning to level off at 50 operations and becoming stable after 75. Table II itemizes some of the complication categories and lists the differences between the first 50 and second 50 operations. The differences in conversion and admission rates were significant, and the difference in rates of other complications approached statistical significance.

Outpatient surgery was successful in 90 operations, with subsequent admission to hospital in 10 cases (between the 1st and 46th operations): 8 patients

stayed overnight and 2 patients stayed 2 days. There was 1 readmission (42nd operation): a patient required a 7-day readmission for conservative management of profound ileus. Five operations (between the 1st and 46th operations) were converted to open repair. The reason for conversion was an equipment problem (2 patients), surgical difficulty (2 patients) and inability to control epigastric artery bleeding (1 patient). All patients whose operation was converted were admitted, staying an average of 1.2 days.

There were 4 recurrences (2 in each group of 50 operations) for a short-term recurrence rate of 2.9% (median follow-up of 28 months). Two of the recurrences occurred within the first 10 operations using the Ethicon stapler and 2 occurred among the first 5 operations after switching to the Auto-Suture stapler. None of the recurrences followed repairs of previous recurrences. Two of the recurrences were in patients who had had extensive pelvic radiation and 1 was in a man with cirrhosis whose recurrence came after the development of massive ascites; his recurrent hernia consisted of a sac filled with fluid only. Reoperations for reasons other than recurrence followed operations 49 and 55.

To date there have been no trocar injuries, trocar site herniation, bowel obstruction from adhesions or mesh infections. There were 24 other complications apart from conversions, admissions, readmissions and recurrences. Five patients (operations 2, 11,

17, 32 and 56) had scrotal hematomas that required several months to reabsorb. One hematoma (operation 56) led to exploration and evacuation to exclude an incarcerated recurrent hernia. There were 3 injuries to epigastric vessels (operations 9, 22 and 50), 1 of which led to conversion (operation 22). There were 2 injuries to the cord (operations 10 and 36), 1 of which was followed by testicular infarction (operation 36). One bladder perforation was repaired laparoscopically (operation 11). One patient had hypoxia, requiring admission (operation 33). Two patients had wound infections (operations 6 and 69), 1 suffered urinary retention (operation 13), 1 had severe postoperative pain requiring admission (operation 72) and 1 had 4 weeks of severe localized postoperative pain (operation 30). There were 7 additional miscellaneous problems of a very minor nature (2 in the first 50 operations and 5 in the last 50).

During the study period, 22 open hernia repairs were also booked. Of these, 8 were for high-risk patients whose operations were done under spinal or local anesthesia. Four patients requested conventional repair (including 1 after a recurrence following laparoscopic repair). Three patients had large hydrocoeles, for whom repairing the hernia and excising the hydrocoele through 1 incision precluded the laparoscopic approach. In 1 patient, an incarcerated hernia with a narrow neck was assumed to be irreducible laparoscopically. In another patient, who underwent groin exploration for a presumed lymphoma, a hernia was found instead, and in another 2 patients groin exploration was felt to be more suitable after previous laparoscopic problems. For 3 patients, no reason was recorded for the choice of open repair.

During the first 2 years of the study

Table I

Average Surgical Times (Minutes) for Unilateral and Bilateral Laparoscopic Inguinal Hernia Repairs

Type of operation	Quartile of operations			
	1st	2nd	3rd	4th
Unilateral	59	45	38	37
Bilateral	69	67	58	52

it was customary to admit patients after open hernia repair. A comparison of total hospital costs in 1992 showed that laparoscopic repairs cost \$85 less per case because of their 90% outpatient management. Since 1994, however, all hernia repairs are booked on an outpatient basis, which works out successfully for 87% of patients who undergo open repairs and for 90% of those with laparoscopic repairs. As a result, laparoscopic inguinal hernia repair in 1995 cost \$274 more per case than open repair.

DISCUSSION

Almost all the variables in the study showed a distinct change after 50 operations, correlating exactly with the estimates of experienced laparoscopic herniorrhaphists, that is, that 50 operations are required to complete the learning curve for laparoscopic inguinal hernia repair. Of course, these findings do not necessarily transpose to all surgeons or practice settings. Clearly, the learning curve varies with the frequency in which patients are operated on, the extent of instruction, the type and volume of the practice, and many parameters peculiar to the individual surgeon. Nevertheless, in

the absence of data based on detailed studies of a substantial number of surgeons in a variety of practice settings, this study provides the best available documented measure of the learning curve for a general surgeon in a community hospital who does not limit his work to hernia repair or laparoscopy. As such, it may serve to inform other community-based general surgeons about what they may reasonably expect should they wish to take up this technique: provision of a solid repair but with a long learning curve and many complications, requiring general anesthesia and costing considerably more than similar open methods.

Thus, when choosing from the many available and apparently successful techniques of hernia repair, all of these factors should be considered. If this extensive learning curve is indeed representative of community surgical practice, a surgeon who averages 1 hernia repair per week will require over 1 year to master the technique, since all cases are not suitable for laparoscopy; a surgeon averaging 20 to 25 hernia repairs per year may need 3 years to master the operation.

In fact, knowing the learning curve for a procedure may be as important as knowing its best indications. The la-

paroscopic approach permits simultaneous repair of bilateral hernias and is a technically easier approach to recurrent hernias than the open method. The distinct advantage of this approach over other preperitoneal mesh techniques is the ability to discover and repair unsuspected contralateral hernias: in this study, 30% of all patients coming for unilateral hernia repair had unsuspected contralateral hernias that were found and repaired at the same time. However, even for bilateral or recurrent hernias, laparoscopic inguinal hernia repair may not be the treatment of choice in the hands of a surgeon who has not mastered the technique.

Knowledge of the learning curve is also an important consideration in the design of comparative studies. If the learning curve of a procedure is 50 operations, then it is not meaningful to compare this technique in the hands of a surgeon after he or she has done 10 to 20 operations against an alternative technique that the surgeon knows well.

This study confirms that a laparoscopically applied tension-free preperitoneal mesh results in an effective repair. To begin performing a new procedure on all patients without selection, starting with the very first case, including the learning curve and including bilateral and multiply recurrent cases, a 3% early recurrence rate is acceptable. Although the numbers are too small to deduce significance, recurrence seemed to correlate with each new stapler rather than the learning curve. If valid, this observation suggests that each stapler has its own learning curve. It may be realistic to expect some failures every time major instrumentation is changed, even if the change means better equipment, but eventually development of a better stapler should allow the recurrence rate to approach zero.

Table II

Differences in Complication Rates and Other Problems Between the First and Second 50 Laparoscopic Operations for Inguinal Hernia Repair

Type of problem	Operation group		p value
	1-50	51-100	
Conversion	5	0	< 0.05
Admission	10	0	< 0.05
Complications	16	8	< 0.063
Readmission	1	0	> 0.05
Reoperation	1	1	> 0.05
Recurrence	2	2	> 0.05

Finally, the learning curve provided 3 “learning experiences,” which led to changes in practice. These are offered to share the experience and insights gained, not to suggest that anecdotal experience is a valid reason for modifying practice.

The unsuspected contralateral hernia

Of all the patients booked for a unilateral hernia repair, 30% were seen to have an asymptomatic contralateral hernia that was not detected by examination. Initially these were not repaired until 1 such patient returned to the emergency room 3 months post-operatively with a contralateral incarceration. Since then, all hernias seen at laparoscopy are repaired. Although the incidence of incarceration of an

unsuspected hernia is rare, repair of the other side adds little morbidity and requires only an additional 15 minutes.

The hernia without peritoneal defect

In 1 patient, no intraperitoneal defect could be seen despite a clinically detected hernia. A misdiagnosis was suspected and the repair was not carried out. Symptoms persisted, as did the finding of a groin lump. Open exploration revealed herniated preperitoneal fat through a direct defect, without peritoneal dimpling. Since then, when a hernia is felt preoperatively, repair is carried out even if no peritoneal defect is apparent; laparoscopic dissection has always demonstrated a defect and repair has resulted in cure.

False recurrence

Laparoscopic repair, particularly with direct hernias, is often followed by a tender groin lump. Exploration in 1 patient revealed this lump to be a hematoma in the dead space of the hernia. Such lumps should be observed, as in every instance the “recurrence” has disappeared by 3 months after surgery.

CONCLUSIONS

The learning curve for laparoscopic inguinal hernia repair in my experience was at least 50 operations and was associated with significant patient morbidity. In addition, major instrument changes may have their own learning curves, even after a stable state has been reached.

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