# CURRENT SURGICAL APPROACHES TO THE TREATMENT OF INGUINAL HERNIAS AND FACTORS ASSOCIATED WITH THE USE OF LAPAROSCOPY

Michael Trevisonno

Department of Experimental Surgery

McGill University, Montreal

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**ABSTRACT**

**Background:** There is controversy among surgeons regarding the treatment of inguinal hernias. Despite the potential advantages of laparoscopic inguinal hernia repair (LIHR) in appropriate clinical situations, many surgeons do not use this technique. The purpose of this 2-part project was to: (1) using a population-based analysis, report practice patterns among Quebec surgeons for the treatment of inguinal hernias and identify factors that may be associated with the choice of operative approach; and (2) using a survey, describe perceived indications for LIHR, and identify barriers to its adoption and educational needs of surgeons.

**Methods**: (1) The population-based analysis used RAMQ and MED-ECHO administrative databases to identify patients who have undergone an inguinal hernia repair between 2007 and 2011 in Quebec, Canada. A generalized linear model was used to identify predictors associated with the selection of a laparoscopic approach. (2) The survey was web-based and was sent to general surgeons and residents. The 33-item survey was divided into 4 sections: demographics, utilization of techniques, management based on 11 clinical scenarios, and educational needs and barriers to LIHR.

**Results**: (1) 49,657 inguinal hernias were repaired over the four-year study period by 478 surgeons. Eight percent of repairs were performed using a laparoscopic approach. LIHR was used to repair 28% of bilateral hernias, 10% of recurrent hernias, 6% of unilateral hernias, and 4% of incarcerated hernias. 268 (56%) surgeons did not perform any laparoscopic repairs, and 11 (2%) surgeons performed more than 100 repairs. These 11 surgeons were responsible for performing 61% of all laparoscopic cases. (2) 697 general surgeons and 206 general surgery residents responded to the survey. 280 (46%) of these surgeons never perform LIHR. Of these surgeons, 70% consider the benefits of laparoscopy to be minimal, 59% said they lack the requisite training, and only 26% are interested in learning. Surgeons (70%) and residents (73%) agreed that the best educational method would be a course followed by expert proctoring.

**Conclusion:** Surgeons remain divided on the utility of laparoscopic surgery for inguinal hernia repair. Half of Quebec's surgeons and half of the surveyed surgeons never perform LIHR. Educational programs need to be implemented for surgeons who want to learn and who have a sufficient volume of procedures to overcome the learning curve.

**RÉSUMÉ**

**Contexte:** Le traitement chirurgical des hernies inguinales fait l'objet d'une controverse parmi les chirurgiens. Bien que les avantages potentiels d'une réparation laparoscopique d'une hernie inguinale (RLHI) soient connus, la communauté chirurgicale n'a pas tout à fait adopté cette pratique. Le but de ce projet en 2 parties était de: (1) à l'aide d'une analyse représentative de la population dresser un bilan sur les tendances des pratiques de traitement des chirurgiens québécois sur une hernie inguinale et afin d'identifier les facteurs pouvant influencer le choix de l'approche chirurgicale; et (2) à l'aide d'un sondage, identifier les indications perçues d'une RLHI ainsi que pour identifier les obstacles à son adhésion et aux besoins éducatifs des chirurgiens.

**Méthodes:** (1) L'analyse représentative de la population utilise la base de données administratives de la RAMQ ainsi que la base de données MED-ÉCHO afin d'identifier les patients qui ont subi une réparation d'une hernie inguinale entre 2007 et 2011 au Québec. Un modèle linéaire généralisé a été utilisée afin d'identifier les variables explicatives associées au choix de l'approche laparoscopique. (2) L'enquête a été réalisée à l'aide d'une application Web et a été envoyée aux chirurgiens généralistes et aux médecins résidents. Ce sondage portant sur 33 points était divisé en quatre sections: la démographie, l'utilisation de techniques, une gestion basée sur onze scénarios cliniques et les besoins éducatifs et les obstacles à une RLHI.

**Résultats:** (1) 49 657 hernies inguinales ont été réparées au cours de la période d'étude de quatre ans par 478 chirurgiens. Huit pour cent des réparations ont été effectuées en utilisant une approche laparoscopique. La RLHI a été utilisée pour réparer 28% des hernies bilatérales, 10% des hernies récidivantes, 6% des hernies unilatérales, et 4% des hernies incarcérées. 268 (56 %) des chirurgiens n'ont pas effectué les réparations laparoscopiques, et 11 (2 %) des chirurgiens ont effectué plus de 100 réparations. Ces 11 chirurgiens étaient chargés d'effectuer 61% de tous les cas de laparoscopie. (2) 697 chirurgiens généraux et 206 résidents en chirurgie générale ont répondu à l'enquête. 280 (46 %) de ces chirurgiens n'effectuent jamais de RLHI. Parmi ces chirurgiens, 70% considèrent que les avantages de la laparoscopie sont mineurs, 59% ont dit qu'ils n'ont pas la formation requise, et seulement 26% sont intéressés à en apprendre davantage. Les chirurgiens (70%) et les résidents (73%) étaient d'avis que la meilleure méthode d'apprendre serait de suivre un cours suivi d'une surveillance par un expert.

**Conclusion:** Les chirurgiens demeurent partagés quant au recours à la chirurgie laparoscopique pour réparer une hernie inguinale. La moitié des chirurgiens québécois et la moitié des chirurgiens interrogés n'ont jamais réalisé de RLHI. Des programmes d'enseignement doivent être implantés pour les chirurgiens souhaitant apprendre et surmonter la courbe d'apprentissage.

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## AUTHOR CONTRIBUTIONS

Michael Trevisonno wrote this thesis and is the primary author of both manuscripts. He was involved in the study design, the acquisition and interpretation of data, and drafting the manuscripts. Dr. Melina C. Vassiliou was the thesis supervisor and contributed vastly throughout the entire process. Liane S. Feldman and Gerald M. Fried assisted with the project designs, the development of the survey in manuscript B, and the revision of the manuscripts. Yusuke Watanabe assisted with the project designs of both manuscripts. Ekaterina Lebedeva assisted with the survey design in manuscript B. Pepa Kaneva made substantial contributions to the statistical analysis of both studies.

## 1. INTRODUCTION

Inguinal hernia repair is the most common procedure in general surgery, impacting over 800,000 people annually in the United States[1]. Over the years, numerous trials have compared open to laparoscopic inguinal hernia repair, but surgeons continue to debate the best surgical approach. Laparoscopic inguinal hernia repair (LIHR) has consistently been found to result in a quick recovery and prompt return to usual activities[2]. In addition, LIHR can benefit patients with certain hernia types, such as recurrent or bilateral hernias[3].

Guidelines have been published by societies and groups of experts with recommendations as to what is the best approach for patients with different characteristics and hernia types[4]. Despite guidelines and trials providing evidence to support the potential advantages of LIHR, the surgical community has not embraced it. Population-based studies have shown that open hernia repair is much more commonly used than a laparoscopic approach[1,5]. This is thought to be due to the fact that LIHR is a technically more difficult operation. It has been associated with a steep learning curve during which complications are increased[6]. Training programs for surgeons are limited, and residency training in LIHR appears to be inadequate[7].

In order to better understand practice patterns and perceptions about LIHR among surgeons, a population-based analysis was performed, and a survey was created and circulated. In the first manuscript, we used Quebec's administrative

healthcare databases- RAMQ and MED-ECHO. Patients who have undergone an inguinal hernia repair were identified with the objectives of:

1) Reporting practice patterns for the treatment of inguinal hernias among Quebec surgeons.

2) Identifying factors that may be associated with the choice of operative approach.

In the second manuscript, we surveyed a large cohort of general surgeons and residents with the objectives of:

1) Identifying perceived indications for laparoscopic inguinal hernia repair.

2) Identifying barriers to its adoption, and educational needs for surgeons.

Together, the population-based analysis and the survey will help us understand the current role of laparoscopic surgery for inguinal hernia repair. The results provided herein can potentially help guide future training programs.

## 2. BACKGROUND

### 2.1. Inguinal Hernias

An inguinal hernia is a protrusion of an organ or structure through a weakness in the groin. It may appear as a lump from the outside. Inguinal hernias may cause discomfort and can limit daily activities. The two most common types of inguinal hernias are: direct and indirect. Femoral hernias are less common, accounting for 3% of all hernias, and are occur more commonly in women[8]. Direct inguinal hernias penetrate directly through the posterior inguinal wall, medial to the inferior epigastric vessels. Indirect inguinal hernias protrude through the internal ring. Rarely, bowel can slip through the hernia and become trapped outside of the abdominal cavity, a process known as incarceration. This is one of the most common causes of bowel obstruction. With prolonged incarceration, blood supply to the bowel can be compromised and strangulation can occur[9].

Approximately 27% of males and 3% of females will develop an inguinal hernia in their lifetime[10]. People with an increased risk of developing inguinal hernias include: smokers, patients with positive family history, collagen disease, COPD, abdominal aortic aneurysms, after an appendectomy or prostatectomy, and after long-term heavy work[4].

Surgery is the most effective treatment option for inguinal hernias. Inguinal hernia repair is one of the most common surgical procedures performed worldwide, with an estimated 800,000 performed annually in the United States[1]. A Quebec study from 1988 estimated that 14,000 are performed annually in the province[11]. Inguinal hernias have an impact on patients' quality of life, with 11% reporting

some form of chronic pain after surgery[12]. The impact on society and healthcare systems is also significant with abdominal wall repairs accounting for nearly $2.5 billion dollars of yearly expenditures in the United States[1].

### 2.2. Surgical Treatment Options

The surgical treatment of inguinal hernias has changed considerably over time. In the sixteenth century, surgeons used a red-hot iron to cause inflammation and reinforce the hernia orifice[13]. In 1877, German surgeon Vincenz Von Czerny was the first to surgically repair an inguinal hernia by narrowing the inguinal canal[13]. In modern times, hernia repairs have been categorized as either tissue-based or prosthetic-based techniques. An open repair involves making an incision on the muscular wall of the patients abdomen. Sutures are used to reconstruct the fascia transversalis. However, the tension caused by these sutures results in post-operative discomfort, and a high recurrence rate[14]. To this day, sutured techniques are recommended only when mesh is not available or is contraindicated.

The first open, tension-free hernia repair using prosthetic mesh was introduced by Irving Lichtenstein in 1984 and is termed the Lichtenstein Repair[15]. Today, the Lichtenstein technique is the most commonly used method[1]. An incision is made in the skin above the pubic tubercle. After the hernia defect is dissected, and the sac reduced, a mesh is placed on the flat posterior wall. This technique is extremely efficient; for the surgeon it is simple and quick to perform, and for the patient there is little pain and they can quickly return to usual activities[10].

Laparoscopic surgery was first introduced as a method to repair inguinal hernias in 1983 by surgeon Ralph Ger[16]. He used metal clips to occlude the peritoneal opening of the hernia sac. The most common laparoscopic techniques used today are the totally extraperitoneal (TEP) repair, and the transabdominal preperitoneal (TAPP) repair. Both techniques require the use of general anaesthesia and synthetic mesh. TAPP requires access to the hernia site through the peritoneal cavity. In TEP, the peritoneal cavity is not entered. Instead, the hernia site is accessed via the pre-peritoneal plane, and mesh seals the hernia outside the peritoneum. Both techniques allow for visualisation of the entire inguinal floor, which will reveal any direct, indirect, or femoral hernias[10].

### 2.3. Laparoscopic Versus Open Repair

The benefits of laparoscopic over open inguinal hernia repair have consistently been debated in the literature. In 2003, McCormack et al. performed a systematic review of 41 randomized controlled trials comparing open repair to laparoscopic repair[2]. They found laparoscopic repair to be associated with less postoperative pain and numbness, a lower incidence of wound infection and haematoma formation, and a quicker return to normal activities and work. However, laparoscopic repair was associated with a longer operating time, more seromas, and a higher rate of serious intraoperative complications (although infrequent). There was no difference in recurrence rates between laparoscopic and open mesh techniques.

General surgeons in favour of LIHR also promote its benefits for bilateral and recurrent hernias[3]. Laparoscopic repair is advantageous in that bilateral hernias can be repaired at the same time, and undetected hernias on the opposite side can be ruled out. The TAPP technique is very effective at rapidly assessing contralateral hernias[17]. Early detection of these contralateral hernias eradicates the need for reoperation, thereby reducing overall costs to the healthcare system and reducing further work loss for the patient[18]. For recurrent hernias after previous open repair, LIHR is thought to be advantageous in that a new plane of dissection is used that is free of scarred tissue from the previous repair. Yang et al. performed a meta-analysis of randomized controlled trials comparing laparoscopic to Lichtenstein repair of recurrent inguinal hernias[19]. They found wound infection rates and chronic pain to be less frequent among patients receiving a laparoscopic approach (OR = 0.28 95%CI: 0.08-0.97; OR = 0.33 95%CI: 0.17-0.68, respectively).

Chronic pain is a primary concern for surgeons operating on inguinal hernias. One meta-analysis showed an 11% incidence of chronic pain[12]. Among these patients, 64% had an aching pain, 9% had numbness, and 9% had testicular pain. Patients most likely to benefit from surgery were those who had moderate or severe pain in the first place; whereas, patients with no pain from the hernia were made worse after surgery[20]. Laparoscopic repair was found to cause less chronic pain than open mesh repair 5 years following operation[21]. The European Hernia Society guidelines say laparoscopic repair is superior to open mesh when only considering chronic pain[4]. These differences seem to decrease over time for pain, but not for numbness.

Several trials have compared the cost-effectiveness of laparoscopic and open repair, as inguinal hernias represent a significant burden on healthcare systems[1]. In 2005, McCormack et al. performed another systematic review evaluating the economics of these techniques[22]. 14 studies were included in this review, and they found LIHR to be more costly than open repair. However, open repair provided less Quality Adjusted Life Years (QALYs). Since laparoscopic repair allows for a quicker return to work, the amount of lost income is reduced. They also found LIHR to be most effective for bilateral hernias, as operation times and recovery times are reduced. One large multi-center trial in the United Kingdom found LIHR to be about £300 more expensive than open mesh repair. These extra costs were due to additional operating time, and increased equipment and sterilization costs[23].

### 2.4. Surgical Guidelines

Since operating techniques vary significantly among surgeons, the European Hernia Society (EHS) published guidelines with indications for using laparoscopic and open inguinal hernia repair[4]. These guidelines are evidence-based, and were agreed upon by members from 14 different countries. The committee did not recommend operating on young males with minimal or no symptoms. All male adults with symptomatic primary hernias should be operated on using a mesh technique, either Lichtenstein or laparoscopic, depending on surgical expertise. Women should be offered a laparoscopic repair because of the higher incidence of recurrence following open repairs. They also recommended a laparoscopic approach to be considered for bilateral hernias and for recurrent hernias after

previous anterior repair. A Lichtenstein repair is recommended for large scrotal hernias, after previous abdominal surgery, when general anesthesia is not advised, and after previous laparoscopic repair. Besides the Lichtenstein or laparoscopic techniques (TEP and TAPP), the committee did not consider any other mesh-based techniques because they have not been sufficiently evaluated.

In 2011, The Danish Hernia database published their version of surgical guidelines[24]. Their guidelines are based on their extensive database that records outcomes of more than 10,000 patients annually. They strongly recommended a laparoscopic approach for women and for recurrent hernias after previous open repair. The National Institute for Clinical Excellence in England also published guidelines and suggested a laparoscopic approach for bilateral hernias and recurrent hernias. They emphasized that both the TAPP and TEP techniques should only be offered by expert surgeons who regularly perform these procedures[25].

In 2011, Bittner et al. published guidelines for using the laparoscopic techniques, and found that both TEP and TAPP are acceptable treatment options for inguinal hernia repair, but there is insufficient data to compare the effectiveness between them. They found that serious adverse events are rare for both techniques, and there is no difference in complication rates between the two[17].

### 2.5. Utilization of Laparoscopic Repair

Despite the potential advantages of laparoscopic surgery, the surgical community has not embraced it for inguinal hernia repair. It has not gained

widespread acceptance as with other laparoscopic procedures such as Cholecystectomy or Nissen Fundoplication. In the United States 14% of inguinal hernia repairs were reported to be laparoscopic[1]. One large population-based analysis in Florida revealed that 19.5% are repaired using LIHR[5]. Although recurrence is an indication for LIHR, only 20.5% of recurrent hernias in this study were repaired using this technique. Patients treated with a laparoscopic approach were younger, more likely to be female, white, and have private insurance.

Zendejas et al. performed a population-based analysis in Olmsted County, Minnesota from 1989 to 2008[26]. They found that non-mesh techniques dominated in the 1980's (94% in 1989), but declined to 4% in 2008. Open mesh repairs reached a peak in 2001 with 72% and declined to 55% in 2008. Laparoscopic repairs were first performed in 1992 (6%) and increased to 41% in 2008.

In Denmark, the rate of laparoscopic repair has increased slowly over the years, and has reached 16% of the total repairs in 2008. Most laparoscopic repairs were performed using the TAPP technique. The main indications were for recurrent and bilateral hernias[27].

Approximately 70,000 Inguinal hernia repairs were performed in 2001 in England, of which 4.1% were repaired using LIHR. After the National Institute of Clinical Excellence published guidelines recommending LIHR as a treatment option, this percentage has risen to 13.28% for primary hernias and 20.30% for recurrent hernias in 2007[28]. No data exists on the uptake of LIHR in the province of Quebec.

## 2.6. Learning Curve and Training

One potential reason for the low uptake of LIHR is that it is challenging procedure associated with a steep learning curve. Learning curves for surgical procedures are evaluated by operation times, conversion rates, recurrences rates, and complications. Laparoscopic inguinal hernia cases performed by experienced surgeons have been proven to result in less conversions, fewer recurrences, a quicker return to usual activities, and greater patient satisfaction[6]. Surgeon experience also influences operation times. On average, inexperienced surgeons take 70 minutes to perform TAPP and 95 minutes to perform TEP; Whereas, experienced surgeons take 40 minutes to perform TAPP and 55 minutes to perform TEP[29]. Surgeons find the TEP and TAPP techniques difficult because their working space is reduced, and because they are unfamiliar with this region of the pelvic anatomy. Open Lichtenstein repair also has a learning curve, but this procedure is easier and the curve appears to be more favourable than that for laparoscopic repair[30].

EHS guidelines only recommend a laparoscopic approach for experienced surgeons. They state the learning curve to be longer than for an open Lichtenstein approach, with a range between 50-100 repairs and the first 30-50 being most critical[4]. One well-known study published in the New England Journal of Medicine indicated that surgeons who performed over 250 repairs had a lower recurrence rate compared to surgeons who performed fewer than 250 repairs. This difference was not found among surgeons of different experience for open repairs[31]. Other studies have estimated the learning curve to lower, ranging from 50 to 80

procedures[32-34]. Another study by Neumayer et al. showed that surgeon age was also a factor in the learning curve. Surgeon inexperience and older age were significant predictors of recurrence. An inexperienced surgeon aged 45 and older had 1.72 odds of recurrence compared to a younger inexperienced surgeon[35].

Laparoscopic surgery has become widely implemented in residency programs. Alkhoury et al. investigated the number the of open and laparoscopic cases performed by chief residents between 2000 and 2008[36]. They found that the number of LIHR cases increased by 88%. Senior-level residents in the United States now perform more laparoscopic inguinal hernia cases than open[37]. Training residents in LIHR was shown to be safe and effective; When surgical residents of any experience level performed the TEP technique under staff supervision, complications were minimal and outcomes were excellent[38]. Despite the increase in exposure in residency programs, and the proven safety of supervising trainees in these techniques, surgical residents are not competent by graduation. Qureshi et al. surveyed a large cohort of Canadian general surgery residents and found that 41% said they will not be able to perform LIHR upon graduation, and 31% said they would like to perform LIHR in their future practices but desire further training[7]. The EHS recommends that training for LIHR should commence with junior residents, and all graduating residents should be familiar with the anterior and posterior preperitoneal anatomy of the inguinal region. At least 30-50 procedures should be performed during the course of the residency programs under supervision of an expert surgeon[4].

## 2.7. Studies Using Administrative Data

Administrative databases are now widely used in healthcare research as they provide extensive information of large populations. These databases are advantageous in Canada as there is a universal healthcare system with all medical services being documented. The *Régie de l'Assurance Maladie du Québec* (RAMQ) is Quebec's universal health insurance program that covers over 99% of the population[39]. Quebec keeps health records through several administrative databases including the RAMQ database and the MED-ECHO (Maintenance et Exploitation des Données pour l'Étude de la Clientèle Hospitaliére) database.

The RAMQ database contains personal information on every insured patient, professional information on the treating physicians, and procedural information based on the medical service claims. Physicians are re-imbursed for their medical acts by submitting a claim to RAMQ documenting the procedural code for the service found in the RAMQ billing manual. Physicians are also asked to submit a diagnosis code using the international classification of diseases, 9$^{th}$ edition (ICD-9).

MED-ECHO is Quebec's hospital discharge database maintained by the Quebec Ministry of Health and Social Affairs. It contains diagnostic and procedural information on all hospitalizations in Quebec since 1987. On April 1, 2006, a new classification system was implemented using ICD-10 codes for diagnosis and Canadian Classification for Health Interventions (CCI) codes for procedures. Day surgeries are included in the MED-ECHO database, but procedures performed in the emergency room or in outpatient clinics are not included. Gaining access to this

database is a time-consuming process, as permission is required from the Commission de l'acces a l'information.

The RAMQ database is thought to be accurate because there are monetary incentives involved. The MED-ECHO database is thought to be reliable because data is recorded from a hospital archivist after reviewing the medical charts. Combining the RAMQ and MED-ECHO database should increase the accuracy of information.

The RAMQ database was found to have diagnostic information that is highly specific, but its sensitivity varies greatly by condition[40]. Levy et al. compared the RAMQ and MED-ECHO databases to medical chart reviews for accurately identifying patients with myocardial infarctions. They found the database to be as reliable as chart review in identifying the patients, but with slight under-reporting of comorbid conditions[41]. The RAMQ and/or the MED-ECHO databases have been used successfully in other studies to identify diseases and comorbidities. They accurately identified patients with cardiac diseases[42-44], asthma[45], COPD[46], psychiatric disorders[47,48], Crohn's disease[49], and others[50,51]. These databases have also been used to identify patients who have undergone surgical procedures such as caesarean sections[52], polypectomies[53], cataract surgeries[54], and corneal transplantations[55]. To date, no other study has used administrative data to investigate inguinal hernia repairs in Quebec.

## 2.8 Studies using surveys

Conducting survey research on physicians is a challenging process. Physicians have demanding schedules, and taking the time to respond to a survey represents a high opportunity cost for them. For this reason, the response rate of physicians is generally 10% lower than the general population[56]. In 2007, Vangeest et al. performed a systematic review investigating methodologies for improving response rates among physicians[57]. They categorize the approaches to increase response rate as: incentive-based approaches and design-based approaches. Physicians were more likely to respond to surveys with monetary incentives (OR=2.13 95%CI: 1.7-2.6). Baron et al. evaluated the cost-effectiveness of a lottery prize on physicians response rate. They performed a randomized trial of 1,000 members of the Quebec Federation of General Practitioners and found that a lottery significantly increased response rate[58]. With regards to survey design, factors that significantly increased response rates were: shorter questionnaires, high quality and appearance, and being sent with a personalized letter[57].

The use of the Internet as a method to disseminate surveys has increased over the years. Web-based surveys are advantageous in that they have a low respondent burden, the respondent can reply at any time of the day, the surveys are quick and easy to respond to, and they are less costly. Physicians who respond to web-based surveys tend to me younger, male, graduates of American medical schools, and working in larger group practices[59].

Several studies have used surveys to investigate the utilization of inguinal hernia repair among general surgeons. Most recently, Morales et al. studied

laparoscopic surgeons' preference for inguinal hernia repair techniques[60]. The majority of these surgeons (82%) offer a tailored-approach depending on the patient and hernia characteristics. A laparoscopic approach was most preferred for bilateral (93%) and recurrent (81%) hernias. The TAPP technique was selected more frequently than TEP.

Results from surveys that were not limited to specialists were not as favorable for laparoscopy. In 2007, a postal survey was sent to all general surgeons in Wales[61]. 15% of responding surgeons use a laparoscopic approach for certain clinical cases, but none use it as their principal technique to repair primary inguinal hernias. The majority (82%) use a Lichtenstein repair for all primary hernias. In 2008, a questionnaire was sent to all 25 surgical departments in Denmark who perform LIHR[27]. Fifteen of these departments only had one or two surgeons performing LIHR. Eleven departments responded that routine indications for a laparoscopic approach include bilateral hernias and recurrent hernias. Five of these departments also included primary hernias and female patients as routine indicators. In 2003, another survey was sent to general surgeons in the Chabu region of Japan. 34% of respondents have experience with LIHR, and only one responder used it as their standard approach[62]. After the National Institute of Health and Clinical Excellence (NICE) published guidelines recommending a laparoscopic approach for certain clinical presentations, a postal survey was sent to Scottish surgeons to investigate if they were adhering to these guidelines[63]. 85% of responding surgeons said at least one surgeon is able to perform LIHR at their hospital. For recurrent hernias after previous open repair, 39% said they would

perform LIHR, and 31% said they would refer their patients to another surgeon who could perform LIHR. For bilateral hernias, 39% said they would perform LIHR, and 28% said they would refer to another surgeon who can perform LIHR. Among surgeons who don't perform LIHR, 61% said there is a lack of training opportunities, and 78% said there is a need for hands-on-courses.

To date, no study has used a large cohort of general surgeons and residents to investigate practice patterns, reasons for selecting the laparoscopic approach, and educational needs.

## 3. MANUSCRIPT A

Title:
CURRENT PRACTICES OF LAPAROSCOPIC INGUINAL HERNIA REPAIR: A POPULATION-BASED ANALYSIS

Authors:
[1]Michael Trevisonno Bsc, [1]Pepa Kaneva MSc, [1,2]Yusuke Watanabe MD, [1]Gerald M. Fried MD, [1]Liane S. Feldman MD,
[1]Melina C. Vassiliou MD

Author Affiliations:
[1]Steinberg-Bernstein Centre for Minimally Invasive Surgery and Innovation McGill University, Montreal, Quebec, Canada
[2]Department of Gastroenterological Surgery II, Hokkaido University Graduate School of Medicine, Sapporo, Japan

Corresponding Author:
Dr. Melina C. Vassiliou MD, M.Ed., FRCS
Assistant Professor of Surgery, McGill University
McGill University Health Centre
1650 Cedar Avenue, L9. 313
Montreal, Quebec, Canada H3G 1A4
Tel: 514.934.1934 x 44330
Fax: 514.934.8210
Email: melina.vassiliou@mcgill.ca

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## Abstract

**Introduction:** The selection of a laparoscopic approach for inguinal hernias varies among surgeons. Despite evidence-based guidelines supporting the utilization of laparoscopic inguinal hernia repair (LIHR) in appropriate clinical settings, it is unclear what is being done in actual practice. The purpose of this study was to report practice patterns for treatment of inguinal hernias among Quebec surgeons, and to identify factors that may be associated with the choice of operative approach.

**Methods:** We studied a population-based cohort of patients who have undergone an inguinal hernia repair between 2007 and 2011 in Quebec, Canada. Healthcare records were extracted from the administrative claims (RAMQ) and hospital discharge (MED-ECHO) databases. A generalized linear model was used to identify predictors associated with the selection of a laparoscopic approach.

**Results:** 49,657 inguinal hernias were repaired over the four-year study period by 478 surgeons. Eight percent of repairs were performed using a laparoscopic approach. LIHR was used to repair 28% of bilateral hernias, 10% of recurrent hernias, 6% of unilateral hernias, and 4% of incarcerated hernias. 268 (56%) surgeons did not perform any laparoscopic repairs, and 11 (2%) surgeons performed more than 100 repairs. These 11 surgeons were responsible for performing 61% of all laparoscopic cases. Patient factors significantly associated with having a laparoscopic repair included younger age, less comorbidities, bilateral hernias, and recurrent hernias. Gender and geographic area of residence were not significant in the selection of operative approach.

**Conclusion:** The utilization of LIHR in Quebec is low, and seems to be below the rate reported in other jurisdictions. An open approach is usually performed for all clinical scenarios, even for cases when published guidelines recommend its use. Surgeons remain divided on the best technique for inguinal hernia repair: Over half of them never perform LIHR, but the few surgeons who perform many of them, use this technique for a large proportion of their cases.

## Introduction

Inguinal hernia repair is one of the most common surgical procedures with practice patterns varying significantly among surgeons. An ongoing debate exists about which is the best surgical approach for patients with different characteristics and hernia types[1]. The type of operative approach can influence quality of life and healthcare expenditures[2]. Laparoscopic inguinal hernia repair (LIHR) has some potential advantages over open surgery, especially for bilateral and recurrent hernias[3]. Evidence-based guidelines were published with the goal of unifying the treatment options for surgeons according to best practices for various clinical presentations[4-6]. Surgeon experience is also a large factor in outcomes for this procedure[7].

Approximately 14,000 inguinal hernias are repaired annually in the province of Quebec, Canada[8]. No data exists on the utilization of laparoscopic repair in this province. Despite evidence-based guidelines, it is unclear as to what is being done in actual practice, and what patient or surgeon characteristics influence the type of operative approach used. A large population-based database was used with the objectives of (1) reporting practice patterns for the treatment of inguinal hernias in the province of Quebec, (2) identifying factors that may be associated with the choice of operative approach.

## Methods

*Study Design*

This study is a population-based retrospective cohort study based on administrative health care data from the province of Quebec, Canada.

*Study Population*

Patients over the age of the 18 who have undergone an inguinal hernia repair in Quebec between April 1, 2007 and March 31, 2011.

*Data Source*

Healthcare records were used from two provincial databases: RAMQ (Régie de l'Assurance Maladie du Québec) and MED-ECHO (Maintenance et Exploitation des Données pour l'Étude de la Clientèle Hospitaliére). RAMQ is Quebec's administrative health claims database, and MED-ECHO is the Ministry of Health's hospital discharge database. RAMQ is the universal health insurance program that covers the cost of medical and hospital care for over 99% of Quebec's residents[9]. The RAMQ database contains personal information on every insured patient, professional information on the treating physicians, and procedural information based on the medical service claims. The MED-ECHO database contains information on hospitalization records including diagnostic and procedural information. RAMQ contains International Classification of Diseases, 9th revision, clinical modification codes (ICD9-CM) and MED-ECHO contains the 10th revision. For this study, RAMQ extracted healthcare records on all patients with an inguinal hernia diagnosis code within the selection

period. Records were extracted commencing one year prior to the study period in order to identify comorbidities.

*Identification of Subjects*

Inguinal hernia repairs were considered for this study when the following inclusion criteria were met:

1) The professional responsible for billing RAMQ for the medical act was the primary physician responsible (to exclude assistants and anesthesiologists).
2) The RAMQ billing code was for an inguinal hernia repair (Table 1).
3) The MED-ECHO ICD10-CM diagnosis code was for an inguinal hernia (Table 1).
4) The MED-ECHO Canadian Classification for Health Interventions (CCI) code was for an abdominal wall repair (Table 1).

The RAMQ billing codes and the MED-ECHO ICD10-CM codes are both necessary as the RAMQ code is not always specific to an inguinal hernia repair (i.e. Code 5054 "repair of a recurrent hernia" does not specify the type of hernia). The CCI codes are necessary as they specify whether the approach used was open or laparoscopic.

*Data Linkage*

The ICD10-CM codes were selected from the MED-ECHO diagnostics dataset, and the CCI codes were selected from the MED-ECHO interventions dataset. These two files were linked using a unique 10-digit identifier for each subject, and a unique 16-digit

identifier for each hospital stay. This final MED-ECHO file was then linked to the RAMQ file using the patient identifier and the date of hernia surgery.

*Outcome*

The primary outcome was the surgical approach being either open or laparoscopic. The MED-ECHO procedural codes were used to indicate whether the approach was open (1SY80LA and 1SY80WJ) or laparoscopic (1SY80DA). Laparoscopic cases that were converted to open were considered laparoscopic, as this was the approach decided prior to surgery. Data was excluded when it was not possible to clearly identify the type of approach.

*Identification of Variables*

*1. Age*

Patients' age was obtained from the RAMQ dataset, and was determined by subtracting the birth date from the date of the first hernia surgery. Age was then classified into 4 categories: 18-34, 35-54, 55-64, and ≥65.

*2. Gender*

Patients' gender was obtained from the RAMQ dataset (binary variable; female, male)

*3. Geographic area of Residence*

The RAMQ dataset placed each patient into one of Quebec's 18 socioeconomic

regions. Each region was then categorized into: urban, sub-urban, or rural, in order to analyze the significance of living in proximity to major medical centers compared to living in more remote areas. The categories were as follows: Montréal, Montérégie, Capitale-Nationale, and Laval as urban, Mauricie, Saguenay-Lac-St-Jean, Outaouais, Laurentides, Estrie, and Lanaudière as sub-urban, and Bas-Saint-Laurent, Abitibi-Témiscamingue, Gaspésie, Chaudières-Appalaches, Côte-Nord, Nord-du-Québec, Nunavik, and Terres-Criesde-la-Baie-James as rural.

*4. Patient displacement*

The RAMQ dataset also provides the socioeconomic region of where the patient was treated. For each patient we identified if the region of residence was the same or different than the region of the treatment center. (Binary variable; same region, displacement)

*5. Type of Hernia*

Hernia characteristics were based on information given in the RAMQ billing codes. From these codes we were able to determine whether the hernia was unilateral or bilateral, primary or recurrent, and if it was incarcerated or strangulated (with or without resection). If multiple inguinal hernia codes were billed on the same day, each of these codes was considered for our classification. For instance, if the surgeon billed for a recurrent hernia and a unilateral hernia, we considered this to be a bilateral and recurrent hernia. See Appendix A for a complete list of RAMQ codes and their classifications.

*6. Comorbidities*

To identify comorbidities, data were extracted beginning on April 1, 2006. ICD9-CM diagnosis codes from the RAMQ dataset and ICD10-CM diagnosis codes from the MED-ECHO dataset were used to identify comorbid conditions. These codes were compiled, and a Charlson Comorbidity Index (CCI) score was calculated for each patient[10]. CCI has been previously adapted for use with administrative data using ICD9 and ICD10 coding[11, 12]. We used these adaptations to help us identify the co-morbid conditions found in the provincial ICD coding manual provided to us by RAMQ. CCI scores were subsequently classified into 4 categories (0, 1, 2, 3, ≥4). A detailed list of all comorbidities along with their ICD codes and CCI weights can be found in Appendix B.

*7. Other surgical procedures on the same day*

RAMQ procedural billing codes were used to identify other surgical procedures that were performed on the same day as the hernia repair. All codes that were considered to be an act of surgery were classified based on body region as follows: abdomen, genitals, pelvis, and other (skin, bone, and connective tissue). See Appendix C for complete list of RAMQ codes with their classification.

We further identified if other non-inguinal hernia procedures were also performed for incisional, umbilical, or epigastric hernias. Certain RAMQ codes indicating an inguinal hernia repair were also identified if an orchidetomy was performed, or if a hydrocele or haematocele was removed.

*8. Experience of the Treating Surgeon*

The decade in which the treating surgeon obtained his/her medical degree was acquired from the RAMQ dataset. The number of years the surgeon has been in practice was devised by subtracting the year corresponding to the mid decade of graduation from the year of the inguinal hernia repair. These years were then categorized into five groups: <10 years, 10 – 19 years, 20 – 29 years, 30 – 39 years, ≥40 years)

*9. Volume of Treatment Center*

Each medical center was assigned a 10-digit de-identified number in the RAMQ dataset. The total number of inguinal hernia repairs that were performed at each treatment center were categorized as follows: ≤500, 501-1000, >1000.

*Statistical Analysis*

Descriptive Statistics were used to summarize the characteristics of the study population and their treating surgeons. Chi-square test was used to compare the surgical approach for each of these characteristics. To identify predictors associated with the selection of laparoscopic repair, we only included the first inguinal hernia repair for each patient, and only considered surgeons who performed laparoscopic repair. In addition, patients who underwent other surgical procedures on the same day were excluded. We employed a generalized linear model to examine the associations between the choice of laparoscopic repair and patient factors of interest. A generalized estimating equations (GEE) approach was used to estimate

the parameters of this generalized linear model, to account for the fact that hernia repair cases clustered within the treating surgeons might be correlated. The interpretation of the estimated coefficients and odds ratios are the same as for a regular logistic regression model. The results are presented as odds ratios with their associated 95% confidence intervals. The statistical analysis was completed using STATA version 12.

*Ethical Considerations*

The institutional review board at McGill University approved this study. Patient and professional information provided by the RAMQ and MED-ECHO databases are de-identified. To access these databases, the study was approved by the *Comission d'Accès à l'Information du Québec***,** a provincial agency that oversees access to governmental information.

## Results

49,657 inguinal hernia repairs were performed on 47,981 patients. 1,676 patients had more than one repair during the 4-year period. 45,855 (92.34%) were performed using an open approach, and 3,802 (7.66%) were performed using a laparoscopic approach. Seventy (0.14%) laparoscopic cases were converted to open. The distribution of characteristics between open and laparoscopic surgeries is detailed in Table 2. A laparoscopic approach was selected for 6.1% of unilateral hernias, 28.1% of bilateral hernias, 9.9% of recurrent hernias, and 6.3% of female

patients. 971 patients had another non-inguinal hernia present, and 1,424 patients had another surgical procedure performed on the same day as the hernia repair. High volume centers performed a greater (11.6%) proportion of laparoscopic cases than lower volume centers (4.2%).

478 surgeons were responsible for performing these repairs. These surgeons practiced in 88 treatment centers in 16 of Quebec's socioeconomic regions (Table 3). Montreal was the region with the most treatment centers (18), the most hernia repairs (13,391), and the most laparoscopic cases (1,127). 3,334 patients from other regions came to Montreal for treatment. Nevertheless, Chaudiere-Appalaches, a rural setting, performed the greatest proportion of cases laparoscopic (17.4%).

268 (56%) surgeons did not perform any laparoscopic repairs. The distribution of laparoscopic repairs performed per surgeon is summarized in Table 4. For the majority of surgeons (75%) who did practice LIHR, it accounted for less than 10% of their practice. For 21 (10%) surgeons, it accounted for over half their inguinal hernia repairs (Table 5). There were 11 surgeons who performed more than 100 laparoscopic cases during the 4-year period. These surgeons were responsible for performing 61% of all laparoscopic cases in the province. They worked in various socioeconomic regions, and all of them had over 20 years of experience. 10/11 used a laparoscopic approach for the majority of their cases (Table 6).

Patient factors associated with the selection of laparoscopic surgery are summarized in table 7. This model included 28,065 patients, among which 12.3%

received a laparoscopic repair. Patient factors significantly associated with having a laparoscopic repair included younger age, less comorbidities, bilateral hernias, and recurrent hernias. Patient factors that were not significant in the selection of operative approach included gender, geographic area of residence, displacement to another region, and incarcerated hernias.

**Discussion**

The utilization of LIHR in Quebec is lower than reported in other jurisdictions. Only 7.7% of all inguinal hernias were repaired using a laparoscopic approach. Other population based studies published in the last decade revealed a higher rate of laparoscopy elsewhere: 16% in Denmark[13], 19.5% in Florida[14], and 41% in Olmsted County, Minnesota[15]. The rate may be lower in Quebec for several reasons. Firstly, Quebec surgeons bill RAMQ for the same monetary sum regardless of whether the approach is open or laparoscopic. Laparoscopic repair takes more operating time[16], and surgeons may not want to invest this time without monetary incentives. Secondly, our study revealed the proportion of LIHR was greater in high volume centers. Since the population of Quebec is small (7.9 million in 2011) for such a large geographic area (population density per square kilometer = 5.8)[17], there may be less high volume centers, and this may account for the low uptake province-wide.

Although Quebec surgeons were more likely to use a laparoscopic approach for bilateral hernias and recurrent hernias, the majority of these hernia types are

still being repaired using an open approach. The European Hernia Society Guidelines recommend a laparoscopic approach for recurrent hernias after previous open repair, and either a laparoscopic or Lichtenstein approach for bilateral hernias[4]. Studies have shown significant benefits of laparoscopic surgery for both of these hernia types[3], and it is the method of choice for most laparoscopic specialists[1]. In this study, bilateral hernias were most commonly selected for laparoscopic surgery. This is advantageous from a socioeconomic perspective, as using a laparoscopic approach for bilateral hernias reduces operating times, and results in a quicker return to work and usual activity[2].

Results from this study revealed several patient factors that predict laparoscopic surgery. Along with bilateral and recurrent hernias, younger age and having less comorbidities were also positively associated with a laparoscopic approach. These results correspond with other population-based studies[14, 15]. Surgeons may be less willing to use general anesthesia on elderly, unhealthy patients, as risks are increased[18]. However, several studies have shown a laparoscopic approach to be safe and effective amongst these patients if the disease is controlled and if hospital stays are kept to a minimum[19].

Surprisingly, gender was not a predictor for laparoscopic repair, even though it is recommended for females given the higher incidence of femoral hernias[4, 5]. Studies have shown a higher rate of recurrence among women undergoing open repair compared to laparoscopic repair[20]. A laparoscopic approach is preferred as its dissection allows for clear exposure of the myopectineal orifice including the

femoral canal[5]. Zendejas et al. showed that LIHR was more likely to be performed in males[15], whereas Smink et al. showed LIHR to be more common in females[14].

This study has shown that the majority of all laparoscopic repairs (61%) were performed by a small group of 11 surgeons who each performed over 100 cases. Out of these 11 surgeons, 10 used a laparoscopic approach for over 50% of all their cases. These surgeons must be seeing benefits of LIHR that the others are not. Since experience is associated with less complications and recurrences[21], perhaps surgeons only see clear benefits once they overcome the learning curve. We initially hypothesized that younger surgeons would be more likely to practice LIHR, since they are now more exposed to laparoscopy in residency programs[22]. On the contrary, all 11 surgeons who performed over 100 repairs have been in practice for over 20 years.

Geographic area of residence was also not significantly associated with the selection of operative approach. Chaudiere-Appalaches had the highest proportion of cases laparoscopic; however, this is because there were three surgeons from this region who each performed over 100 cases. Interestingly, out of the 11 surgeons who performed over 100 LIHR's, only 5 come from urban areas that include the major academic hospitals. With so few experienced surgeons in these academic centers, who is training the residents to become competent in this technique? Qureshi et al. surveyed a large cohort of Canadian general surgery residents and found that 60% will not be able to perform LIHR upon graduation, and 30% would like to perform it and desire further training[23]. Staff surgeons cannot satisfy the

educational needs of these residents with so few performing laparoscopic repairs in our urban academic centers. Perhaps training programs need to be arranged with these experienced surgeons regardless of practice setting or geographic area.

Several limitations must be considered when interpreting the findings of our study. Firstly, misclassification is possible when using administrative healthcare data. The RAMQ and MED-ECHO databases have been shown to identify diseases with a high specificity, but with a lower sensitivity that ranges among conditions[24]. The RAMQ dataset is thought to be reliable because the diagnostic codes are remunerated, and the MED-ECHO dataset is thought to be reliable because they are recorded by trained archivists after thoroughly reviewing the medical charts. Secondly, there were several important factors that we were not able to obtain from our data. We did not have data indicating if the surgery was elective or emergency, among recurrent hernias we did not know the operative approach of the first repair, and we did not have further details on the size or location of the hernia. This information could have influenced the decision to undergo laparoscopic or open repair. Despite these limitations, this study has significant strengths including a large sample size, and use of a database that captures all medical procedures throughout the province.

In conclusion, there appears to be a gap between the best practices put forth in the guidelines, and what surgeons are doing in actual practice. Surgeons must be divided on the benefits of LIHR, as half of them never perform it, and the few surgeons who perform many of them, use it for a large proportion of their cases.

Since LIHR is associated with a steep learning curve, perhaps a high volume of cases is required to encounter these benefits, and only these experienced surgeons are encountering them. Educational programs may be beneficial to train surgeons who have the desire to offer this technique for certain cases, and have the volume to overcome the learning curve.

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## Tables

**Table 1.** RAMQ and MED-ECHO inclusion criteria codes

| Inclusion Codes | Definitions |
|---|---|
| **RAMQ Medical Acts** | |
| 5455 | Inguinal or femoral herniorraphy: simple, unilateral |
| 5456 | Inguinal or femoral herniorraphy: with hydrocele or haematocele |
| 5457 | Inguinal or femoral Herniorraphy: Bilateral |
| 5459 | Strangulated or incarcerated without intestinal resection |
| 5460 | Strangulated or incarcerated with intestinal resection |
| 5461 | Inguinal and Femoral herniorraphy |
| 5468 | Unilateral inguinal herniorraphy with orchidectomy |
| 5476 | Repair of a recurrent hernia |
| 5054 | Repair of a recurrent hernia |
| **ICD10-CM** | |
| K40.0 | Bilateral inguinal hernia, with obstruction, without gangrene |
| K40.1 | Bilateral inguinal hernia, with gangrene |
| K40.2 | Bilateral inguinal hernia without obstruction or gangrene |
| K40.3 | Unilateral or unspecified inguinal hernia, with obstruction, without gangrene |
| K40.4 | Unilateral or unspecified inguinal hernia with gangrene |
| K40.9 | Unilateral or unspecified inguinal hernia without obstruction or gangrene |
| **CCI** | |
| 1SY80LA | Reparation of the muscles of the abdomen or thorax using an open approach, without tissue. |
| 1SY80WJ | Reparation of the muscles of the abdomen or thorax using an open approach (Shouldice technique) |
| 1SY80DA | Reparation of the muscles of the abdomen or thorax using a laparoscopic approach. |

**Table 2.** Patient and surgeon characteristics

| Characteristics | Total N(%) | % Open | % Lap | P value |
|---|---|---|---|---|
| **Age** | | | | <0.01 |
| 18 – 24 | 1,776 (3.7) | 92.7 | 7.3 | |
| 25 – 34 | 3,310 (6.9) | 92.1 | 7.9 | |
| 35 – 44 | 5,555 (11.6) | 89.9 | 10.1 | |
| 45 – 54 | 9,795 (20.4) | 90.5 | 9.5 | |
| 55 – 64 | 11,547 (24.0) | 91.6 | 8.4 | |
| 65 – 74 | 9,435 (19.7) | 93.5 | 6.6 | |
| 75 – 84 | 5,609 (11.7) | 96.2 | 3.8 | |
| 85+ | 954 (2.0) | 97.8 | 2.2 | |
| **Gender** | | | | <0.01 |
| Male | 44,953 (93.7) | 92.2 | 7.8 | |
| Female | 3,028 (6.3) | 93.5 | 6.5 | |
| **CCI** | | | | <0.01 |
| 0 | 36,938 | 91.7 | 8.3 | |
| 1 | 5,884 | 93.2 | 6.8 | |
| 2 | 2,543 | 94.2 | 4.8 | |
| ≥ 3 | 2,616 | 95.7 | 4.3 | |
| Missing | 97 | 93.8 | 6.2 | |
| **Geographic Area of Treatment Center** | | | | <0.01 |
| Urban | 25,984 | 91.2 | 8.8 | |
| Sub-urban | 15,308 | 94.5 | 5.5 | |
| Rural/Remote | 6,592 | 91.3 | 8.7 | |
| Missing | 97 | 93.8 | 6.2 | |
| **Geographic Area of Treatment Center** | | | | <0.01 |
| Urban | 27,321 (56.9) | 91.1 | 8.9 | |
| Sub-urban | 14,434 (30.1) | 95.1 | 4.9 | |
| Rural/Remote | 6,226 (13.0) | 90.8 | 9.2 | |
| **Displacement** | | | | 0.15 |
| Same region | 41,246 | 92.4 | 7.6 | |
| Other region | 6,638 | 93.8 | 6.2 | |
| **Laterality** | | | | <0.01 |
| Unilateral | 44,398 (92.5) | 93.9 | 6.1 | |
| Bilateral | 3,583 (7.5) | 71.9 | 28.1 | |

| | | | | |
|---|---|---|---|---|
| **Recurrence** | | | | <0.01 |
| Primary | 45,668 (95.2) | 92.4 | 7.6 | |
| Recurrent | 2,313 (4.8) | 90.1 | 9.9 | |
| **Incarcerated** | | | | <0.01 |
| Not incarcerated | 43,881 (91.5) | 91.9 | 8.1 | |
| Without resection | 4,009 (8.4) | 96.0 | 4.0 | |
| With resection | 91 (0.2) | 93.4 | 6.6 | |
| **Hydrocele or haematocele** | 125 (0.3) | 96.0 | 4.0 | |
| **Orchidectomy** | 64 (0.1) | 90.6 | 9.4 | |
| **Other hernia-type present** | | | | <0.01 |
| Incisional | 294 (0.6) | 82.7 | 17.4 | |
| Umbilical | 618 (1.3) | 89.6 | 10.4 | |
| Epigastric | 59 (0.1) | 86.4 | 13.6 | |
| **Other Sx performed** | | | | <0.01 |
| Abdominal | 256 (0.5) | 78.5 | 21.5 | |
| Genital | 434 (0.9) | 91.9 | 8.1 | |
| Pelvic | 148 (0.3) | 94.6 | 5.4 | |
| Other (skin, bone, soft tissue) | 586 (1.2) | 95.2 | 4.8 | |
| **Surgeons' Experience** | | | | <0.01 |
| < 10 years | 5,349 (11.2) | 93.7 | 6.3 | |
| 10 – 19 years | 13,833 (28.8) | 97.2 | 2.8 | |
| 20 – 29 years | 11,688 (24.4) | 87.7 | 12.3 | |
| 30 – 39 years | 9,368 (19.5) | 84.4 | 15.6 | |
| ≥ 40 years | 7,267 (15.2) | 98.8 | 1.2 | |
| Unknown | 476 (1.0) | 99.6 | 0.4 | |
| **Volume of Treatment Center (total repairs)** | | | | |
| ≤ 500 | 7,771 (16.2) | 95.8 | 4.2 | <0.01 |
| 501 – 1000 | 21,192 (44.2) | 94.4 | 5.6 | |
| > 1000 | 19,018 (39.6) | 88.4 | 11.6 | |

**Table 3.** Quebec's 18 socioeconomic regions

| Region | Urbanicity | Treatment Centers | Total Repairs | Lap. Repairs N(%) | Displaced to other | Displaced here |
|---|---|---|---|---|---|---|
| Montréal | Urban | 18 | 13,391 | 1,127 (8.4) | 729 | 3,334 |
| Montérégie | Urban | 10 | 8,650 | 691 (8.0) | 1,497 | 565 |
| Capitale-Nationale | Urban | 8 | 4,775 | 563 (11.8) | 102 | 571 |
| Laval | Urban | 1 | 1,476 | 101 (6.8) | 1,428 | 566 |
| Mauricie et Centre-du-Québec | Sub-urban | 6 | 3,965 | 427 (10.8) | 219 | 276 |
| Saguenay - Lac-Saint-Jean | Sub-urban | 5 | 1,878 | 15 (0.8) | 33 | 73 |
| Outaouais | Sub-urban | 5 | 1,561 | 23 (1.4) | 87 | 25 |
| Laurentides | Sub-urban | 5 | 3,399 | 16 (0.5) | 725 | 576 |
| Estrie | Sub-urban | 4 | 1,992 | 47 (2.4) | 251 | 99 |
| Lanaudière | Sub-urban | 2 | 2,096 | 206 (9.8) | 890 | 255 |
| Bas-Saint-Laurent | Rural | 6 | 1,673 | 14 (0.8) | 18 | 72 |
| Abitibi-Témiscamingue | Rural | 5 | 1,036 | 71 (6.9) | 10 | 53 |
| Gaspésie - Îles-de-la-Madeleine | Rural | 5 | 507 | 9 (1.7) | 29 | 8 |
| Chaudière-Appalaches | Rural | 5 | 2,793 | 487 (17.4) | 468 | 153 |
| Côte-Nord | Rural | 2 | 368 | 4 (1.1) | 96 | 5 |
| Nord-du-Québec | Rural | 1 | 72 | 0 (0) | 31 | 7 |
| Nunavik | Rural | 0 | 0 | 0 (0) | 11 | 0 |
| Terres-Cries-de-la-Baie-James | Rural | 0 | 0 | 0 (0) | 14 | 0 |

**Table 4.** The distribution of laparoscopic repairs performed per surgeon.

| Lap. Repairs performed per surgeon | Surgeons N (%) | Total lap. repairs per row |
|---|---|---|
| 0 | 268 (56.1) | 0 |
| 1 - 20 | 179 (37.4) | 542 (14.6) |
| 21 - 50 | 12 (2.5) | 426 (11.5) |
| 51 - 100 | 8 (1.7) | 484 (13.1) |
| 101 - 200 | 8 (1.7) | 1,122 (30.3) |
| > 200 | 3 (0.6) | 1,133 (30.6) |

**Table 5.** Percentage of surgeons' practice using a laparoscopic approach. (Among surgeons who do perform LIHR).

| % of lap repairs per surgeon | Surgeons N (%) | Total Repairs per row | Total Lap per row |
|---|---|---|---|
| < 10% | 157 (74.8) | 22,635 | 375 |
| 10 – 49% | 32 (15.2) | 3,298 | 855 |
| ≥ 50% | 21 (10.0) | 3,347 | 2,477 |

**Table 6.** Details of the 11 surgeons who performed over 100 repairs:

| Lap. Cases | % Lap | Region | Urbanicity | Years in practice |
|---|---|---|---|---|
| 550 | 88 | Chaudiere-Appalache | Rural | 20 - 30 |
| 324 | 69 | Chaudiere-Appalache | Rural | 20 - 30 |
| 272 | 53 | Mauricie-centre de QC | Sub-urban | 30 – 40 |
| 189 | 97 | Mauricie-centre de QC | Sub-urban | 20 - 30 |
| 165 | 68 | Capitale-Nationale | Urban | 20 - 30 |
| 161 | 60 | Montérégie | Urban | 20 - 30 |
| 144 | 47 | Chaudiere-Appalache | Rural | 20 - 30 |
| 138 | 73 | Lanaudiere | Sub-urban | 20 - 30 |
| 133 | 85 | Capitale-Nationale | Urban | 30 – 40 |
| 108 | 98 | Montérégie | Urban | 30 – 40 |
| 106 | 70 | Montreal | Urban | 30 – 40 |

**Table 7.** Patient factors associated with the selection of laparoscopic surgery

| Patient Characteristics | Odds Ratio | 95% Conf. Intervals | |
|---|---|---|---|
| **Age** | | | |
| 18 – 34 | 1.87 | 1.40 | 2.49 |
| 35 – 54 | 2.06 | 1.53 | 2.79 |
| 55 – 64 | 1.67 | 1.34 | 2.07 |
| ≥ 65 | REFERENCE | | |
| **Gender** | | | |
| Male | REFERENCE | | |
| Female | 0.97 | 0.84 | 1.12 |
| **CCI Score** | | | |
| 0 | REFERENCE | | |
| 1 | 0.88 | 0.81 | 0.96 |
| 2 | 0.79 | 0.68 | 0.91 |
| ≥ 3 | 0.64 | 0.54 | 0.76 |
| **Laterality** | | | |
| Unilateral | REFERENCE | | |
| Bilateral | 2.79 | 1.90 | 4.09 |
| **Recurrent** | | | |
| Primary | REFERENCE | | |
| Recurrent | 1.36 | 1.02 | 1.84 |
| **Incarcerated** | | | |
| Not incarcerated | REFERENCE | | |
| Without resection | 0.91 | 0.80 | 1.04 |
| With resection | 1.19 | 0.41 | 3.42 |
| **Geographic Area of Residence** | | | |
| Urban | REFERENCE | | |
| Sub-urban | 1.07 | 0.93 | 1.22 |
| Rural/Remote | 1.09 | 0.88 | 1.35 |
| **Displacement** | | | |
| Same region | REFERENCE | | |
| Other region | 1.06 | 0.98 | 1.14 |

## 4. TRANSITION TO MUNSCRIPT B

The previous study identified a low uptake of LIHR in Quebec among all hernia types. Clearly, surgeons are divided on the selection of approach used to repair inguinal hernias. Unfortunately, from administrative data, we cannot understand why some surgeons choose to perform most of their cases using a laparoscopic approach whereas others are not performing it at all. In the second study, we created a survey to get answers from the surgeons themselves. What are the main barriers for surgeons not performing LIHR? Do they even know how to perform it? Are they interested in learning? Are residency programs adequately preparing the next generation of surgeons to be competent in LIHR? The following study addresses these questions.

## 5. MANUSCRIPT B

Title:
LAPAROSCOPIC INGUINAL HERNIA REPAIR: PRACTICE PATTERNS, BARRIERS, AND EDUCATIONAL NEEDS

Authors:
[1]Michael Trevisonno Bsc, [1]Pepa Kaneva MSc, [1,2]Yusuke Watanabe MD, [1]Gerald M. Fried MD, [1]Liane S. Feldman MD, [1]Ekaterina Lebedeva MLIS, [1]Melina C. Vassiliou MD

Author Affiliations:
[1]Steinberg-Bernstein Centre for Minimally Invasive Surgery and Innovation McGill University, Montreal, Quebec, Canada
[2]Department of Gastroenterological Surgery II, Hokkaido University Graduate School of Medicine, Sapporo, Japan

Corresponding Author:
Dr. Melina C. Vassiliou MD, M.Ed., FRCS
Assistant Professor of Surgery, McGill University
McGill University Health Centre
1650 Cedar Avenue, L9. 313
Montreal, Quebec, Canada H3G 1A4
Tel: 514.934.1934 x 44330
Fax: 514.934.8210
Email: melina.vassiliou@mcgill.ca

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**Abstract**

**Background:** Practice patterns for inguinal hernia repair vary significantly among surgeons. The purpose of this study was to identify perceived indications for laparoscopic inguinal hernia repair (LIHR), and to identify barriers to its adoption and educational needs for surgeons.

**Methods:** A web-based survey was sent via email to general surgery members of several North American surgical societies, and to surgical residents through their program directors. The 33-item survey was divided in 4 sections: demographics, utilization of techniques, management based on 11 clinical scenarios, reasons for not performing LIHR and educational needs for those who want to learn LIHR.

**Results:** 697 general surgeons and 206 general surgery residents responded to the survey. Surgeons with MIS fellowships, and surgeons at the beginning of their careers are more likely to perform LIHR. Out of the 11 clinical scenarios, surgeons preferred a laparoscopic approach (TEP or TAPP) for bilateral (48%) and recurrent (44%) hernias. However, 280 (46%) of these surgeons never perform LIHR. Of these surgeons, 70% consider the benefits of laparoscopy to be minimal, 59% said they lack the requisite training, and only 26% are interested in learning. Surgeons (70%) and residents (73%) agreed that the best educational method would be a course followed by expert proctoring.

**Conclusion:** Surgeons remain divided on the utility of laparoscopic surgery for inguinal hernia repair. Nearly half of responding surgeons never perform LIHR, and the other half offer it selectively. One quarter of surgeons who do not perform LIHR would be interested in learning. This reveals a knowledge gap that could be addressed with educational programs.

## Introduction

Despite the potential role laparoscopic inguinal hernia repair (LIHR) has to play in the treatment of patients with inguinal hernias[1], the procedure has not gained widespread acceptance among surgeons. In the United States only 14-19% of inguinal hernia repairs were reported to be laparoscopic[2-3]. One population-based analysis in Florida revealed that even the majority of recurrent hernias were being repaired using an open approach[3]. In Denmark, the rate of laparoscopic repair has increased slowly over the years, with the main indications being for recurrent and bilateral hernias[4]. The low uptake has been thought to be due to the fact that laparoscopic inguinal hernia repair (LIHR) is a challenging procedure with a steep learning curve and the benefits for patients are still being debated[5].

In 2009, the European Hernia Society (EHS) published guidelines with indications for laparoscopic and open inguinal hernia repair. They recommend a laparoscopic approach to be considered for bilateral hernias, recurrent hernias after previous anterior repair, and for all females. A Lichtenstein repair is recommended for large scrotal hernias, after previous abdominal surgery, and when general anesthesia is not advised. Primary unilateral hernias can be repaired using a Lichtenstein or laparoscopic approach depending on surgeon expertise[1].

Whether these guidelines are being followed and by whom are unclear. While published guidelines can influence clinicians' knowledge of recommended patient care[6], there is little evidence that this information alone changes behavior[7]. Defining the needs of the target audience can help guide educational programs, and

learning based on a needs assessment is most effective at changing physician behavior[8]. Information about who is performing LIHR and why others are not performing it would be helpful in order to guide training. A survey was conducted with the purpose of estimating the extend to which LIHR is used in a cohort of general surgeons, and of identifying practice patterns based on surgeon, patient and hernia characteristics. We also sought to identify barriers to adoption and educational needs among surgeons and residents in training.

**Methods**

A web-based survey was developed in consultation with a group of expert hernia surgeons who perform both open and laparoscopic inguinal hernia repair. The 33-item questionnaire contained sections covering demographics, utilization of hernia techniques, management based on 11 clinical scenarios, barriers and educational needs. For the 11 clinical scenarios, respondents were asked how they would treat various clinical cases involving inguinal hernias. Answer choices included: Watchful waiting, open repair with mesh, open repair without mesh, totally extraperitoneal (TEP) repair, transabdominal preperitoneal (TAPP) repair, or other. See Appendix for the complete survey.

The survey was sent via email to members of the American Hernia Society, the Quebec Surgical Association, and the Ontario Association of general surgeons. Furthermore, a link with access to the survey was posted in the American College of Surgeons NewsScope, and in the Canadian Association of General Surgeons newsletter. The survey was also sent to Canadian general surgery residents via their

program directors. Respondents were entered in a lottery for a chance to win an iPad.

## Results

697 general surgeons and 206 general surgery residents responded to the survey. Among staff surgeons, 644 completed the clinical scenarios section. Of these, 52% practice in Canada, 24% practice in the United States, and 24% practice in other countries. A fellowship in minimally invasive surgery was completed by 25% of respondents.

### Laparoscopic Utilization

347/644(54%) performs LIHR. Surgeons with a fellowship in minimally invasive surgery are more likely to perform laparoscopic repair than those without a fellowship (77% and 45%, respectively). Surgeons at the beginning of their careers are also more likely to perform LIHR than surgeons later in their careers (Figure 1). There were no differences in the proportion of surgeons performing LIHR between different practice settings (Table 1).

### Clinical Management

Seventy six percent (76%) of responding surgeons use an open approach to repair the majority of primary unilateral hernias, whereas 18% use a laparoscopic approach and 6% used both equally. Among surgeons who perform laparoscopic repair, 52% use TAPP for the majority of cases, 43% use TEP, and 5% use both

equally. Mesh is used in the majority of cases by 94% of respondents. The results for all 11 clinical scenarios are summarized in Table 2.

Barriers to the adoption and use of laparoscopic inguinal hernia surgery

611 attending surgeons completed the education section among which 280 (46%) never perform laparoscopic repair. The most common reasons for not adopting LIHR include perceived minimal benefits (70%), lack of training (59%) and increased resource requirements (46%) (Table 3). 151 surgical residents completed the education section. Among these residents, 35% never performed a laparoscopic repair. Perceived barriers for increased use of LIHR at their institutions include lack of training and increased resources (Table 4). Compared to attending surgeons, residents less commonly cited "minimal benefits" as a barrier to use of LIHR (70% vs 30%).

Educational needs of staff surgeons

Of the 280 surgeons who never perform laparoscopic inguinal hernia repair, 74 (26%) are interested in learning. Their preferred educational method was a course followed by expert proctoring, followed by observation of experts in the operating room (Figure 2).

Educational needs of residents

151 surgical residents completed the educational needs section. 88% said they were interested in learning LIHR. 76% said all graduating residents should be competent to perform this technique, but 46% said the graduating residents were not competent. Attending surgeons agreed that residents should all be competent

(66%), but that the residents were not competent by graduation (65%). The majority of residents (50%) responded that at least 50 procedures would be necessary to achieve competence.

**Discussion**

Results from this survey demonstrate variations in practice patterns for the surgical treatment of patients with inguinal hernias. It is not surprising that surgeons with MIS fellowships, and surgeons at the beginning of their careers are more likely to perform laparoscopic repair. Younger surgeons may be more likely to perform LIHR since they are more exposed to the procedure and laparoscopy in general during residency. Senior level residents in the United States are now performing more laparoscopic inguinal hernia repairs than open[9]. Between 1999 and 2008, chief residents in the United States reported a decrease in open hernia repairs by 12.5% whereas laparoscopic repairs increased by 87.5%[10]. These results correlate with our survey results that demonstrate a rise in the uptake of laparoscopic hernia repair among the new generation of surgeons.

In the clinical scenarios in our survey, only 18% of respondents recommend the laparoscopic approach to repair most unilateral hernias. Respondents were more likely to select a laparoscopic approach for bilateral hernias (48%) and for recurrent hernias after previous anterior repair (54%). These results correspond with population-based studies demonstrating higher use of laparoscopic repair for these hernia types[4, 11]. For bilateral hernias, a laparoscopic approach allows the hernias to be repaired with the same incision for both sides, whereas an open

approach requires two separate incisions. There are no robust data clearly demonstrating the benefits of laparoscopic repair for bilateral hernias, and the EHS recommends either a Lichtenstein repair or a laparoscopic repair depending on expertise[1]. For recurrent hernias after a previous open repair, re-operation anteriorly can be challenging. Laparoscopic repair, either TEP or TAPP, is advantageous because another plane of dissection is used. A meta-analysis of randomized controlled trials found laparoscopic repair to be superior to the Lichtenstein repair for recurrent hernias in that it resulted in less wound infections and less chronic pain[12]. Our survey demonstrates that surgeons prefer a tailored approach depending on patient and hernia characteristics, and that a little over half of the surgeons are able to offer a laparoscopic repair depending on the case. A survey by Morales et al. studying preferences for hernia repair in laparoscopic surgeons', similarly found that they use a tailored approach, favoring laparoscopy for recurrent (81%) and bilateral hernias (93%)[13].

On the other hand, nearly half of responding surgeons never perform laparoscopic inguinal hernia repair. Similar uptake has been reported in surveys from different countries[14-15]. Our survey identified the main reason for this low uptake to be a belief that the benefits for patients are minimal. Residents, on the other hand, did not list minimal benefits as a major barrier. The benefits of laparoscopy for inguinal hernias remain controversial, and surgeons are divided on this issue. Numerous trials have concluded that laparoscopic repair results in less postoperative and long-term pain and numbness, a quicker return to normal activity, and the ability to detect occult contralateral hernias. However, it is

associated with increased costs, lengthier operations, and an increased risk of intra-operative complications, although infrequent[5].

The second principal barrier for surgeons was that they lack the requisite training. LIHR is a challenging procedure for the surgeon, and is associated with a steep learning curve during which recurrence rates seem to be increased[16]. The European Hernia Society states that the learning curve for laparoscopic repair is longer than for open repair, and ranges between 50 and 100 procedures[1]. Despite a large randomized North American study reporting higher rates of intraoperative, postoperative, and life-threatening complications for laparoscopic repairs compared to open repairs[16], safety was not a main concern for surgeons who responded to this survey.

Almost all responding residents were interested in learning LIHR. Surgeons and residents believe that all graduating residents should be competent in performing this technique; however, most believe the graduates were not competent at this time. Although residents recognize the value of this procedure, training is inadequate and may be related to a lack of exposure and expertise within programs. One study revealed that resident participation in LIHR requires more OR time, but is safe and associated with similar outcomes to surgeons operating alone[17]. Among staff surgeons who don't perform LIHR, one quarter are interested in learning. This reveals a knowledge gap among practicing surgeons that could be addressed with educational programs. Surgeons and residents agree that the best educational method would be a course followed by expert proctoring. Proctorship following a course is necessary to reduce the risk of complications and recurrences

during the learning curve. The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) published guidelines for integrating advanced laparoscopic procedures such as LIHR into residency programs. They recommend that faculty interact with and observe a skilled peer after having undergone a hands-on course[18]. Laparoscopic colon resection is another procedure with a steep learning curve, and proctored training programs have been shown to be safe, feasible, and necessary to reduce adverse effects[19-20]. However, the practical implications of these recommendations must be recognized. Arranging a proctorship for LIHR may be challenging as there are no established programs, and surgeons may be unwilling to take time off from their busy practices.

We acknowledge there to be several limitations to this study. First, the response rate cannot be calculated given that the survey was sent through several societies of which there would be an overlap of members. Since the American College of Surgeons and the Canadian Association of General Surgeons posted the survey in their newsletters, we do not know how many surgeons accessed the survey. Second, there may be an overrepresentation of responding surgeons with a fellowship in minimally invasive surgery (25%) compared to the general surgical population, which may have biased the results in favor of laparoscopy. Third, the survey was weighted more heavily in Canada because the Quebec and Ontario associations were willing to send the survey directly to their members by email. Finally, we acknowledge that the patient information given in the clinical scenarios is limited and lacks the complexities of dealing with a patient in the real world.

In conclusion, this survey suggests that surgeons remain divided on the surgical approach to inguinal hernias. Nearly half of respondents never perform laparoscopic repair, and the other half offer laparoscopic repair depending on the clinical situation. For the most part, practice patterns seem to reflect recommendations put forth by the EHS, but surgeon expertise appears to be the primary determinant on what operation to offer. Many surgeons who do not have the volume to overcome the learning curve may not want to start using LIHR for challenging cases. This information can be used to develop educational programs that will have the highest likelihood of meeting the needs of target learners. Education programs to increase the uptake of LIHR should focus on dissemination of information regarding the benefits of laparoscopy in terms of chronic pain and numbness, while addressing the practical implications of requiring hands-on training and proctorship to reduce the risk of complications and improve outcomes during early experience.

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## Tables

**Table 1.** Proportion of surgeons performing LIHR in different practice settings.

| Practice Setting | Perform LIHR |
|---|---|
| University/Academic (n=157) | 57% |
| Community hospital Univ. Affiliated (n=185) | 56% |
| Urban hospital not affiliated with university (n=128) | 59% |
| Rural hospital not affiliated with university (n=139) | 44% |
| Outpatient surgical centre (n=13) | 50% |

**Table 2.** Responses to clinical scenario questions reported as percentages (n=644)

| Hernia Type | Scenario | Wait | Open no mesh | Open mesh | TEP | TAPP | Other |
|---|---|---|---|---|---|---|---|
| I. Unilateral | 1. Females | 1% | 17% | 60% | 11% | 10% | 1% |
| | 2. Young, asymptomatic male | 42% | 10% | 29% | 10% | 6% | 2% |
| | 3. Previous prostatectomy | 1% | 5% | 84% | 3% | 5% | 1% |
| | 4. Severe COPD | 5% | 3% | 81% | 3% | 3% | 5% |
| II. Bilateral | 5. Both primary | 0% | 4% | 41% | 24% | 24% | 7% |
| | 6. One side primary, other recurrent after TEP | 0% | 4% | 55% | 5% | 25% | 10% |
| III. Incarcerated | 7. Non-obstructing | 1% | 5% | 82% | 3% | 7% | 2% |
| | 8. Obstructing | 0% | 26% | 61% | 1% | 6% | 6% |
| IV. Recurrent | 9. After previous open | 0% | 3% | 32% | 25% | 29% | 11% |
| | 10. After previous TEP | 0% | 3% | 77% | 1% | 15% | 3% |
| | 11. After previous TAPP | 0% | 4% | 84% | 2% | 6% | 4% |

**Table 3.** Perceived barriers for LIHR adoption for attending surgeons who do not perform LIHR. Respondents could choose more than one option (n=280)

| Barriers | n | (%) |
|---|---|---|
| Minimal benefits | 196 | (70) |
| Lack of training/learning curve | 165 | (59) |
| Increased OR time | 130 | (46) |
| Increased costs | 128 | (46) |
| Use of general anesthesia | 114 | (41) |
| Increased complications | 82 | (29) |
| Increased recurrence rate | 57 | (20) |
| Lack of support from administration | 20 | (7) |
| Patient preference | 12 | (4) |
| Use of mesh | 9 | (3) |

**Table 4.** Perceived institutional barriers for general surgery residents for performing LIHR (n=151).

| Barriers | n | (%) |
|---|---|---|
| Lack of training/learning curve | 120 | (79) |
| Increased OR time | 76 | (50) |
| Increased costs | 47 | (31) |
| Minimal benefits | 46 | (30) |
| Use of general anesthesia | 40 | (26) |
| Lack of support from administration | 17 | (11) |
| Increased complications | 11 | (7) |
| Patient preference | 10 | (7) |
| Increased recurrence rate | 6 | (4) |
| Use of mesh | 2 | (1) |

## Figures

**Figure 1.** Percentage of surgeons performing LIHR based on number of years in practice.

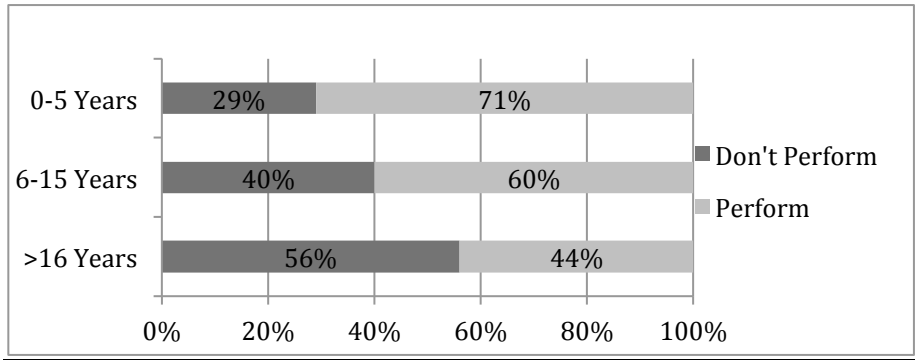
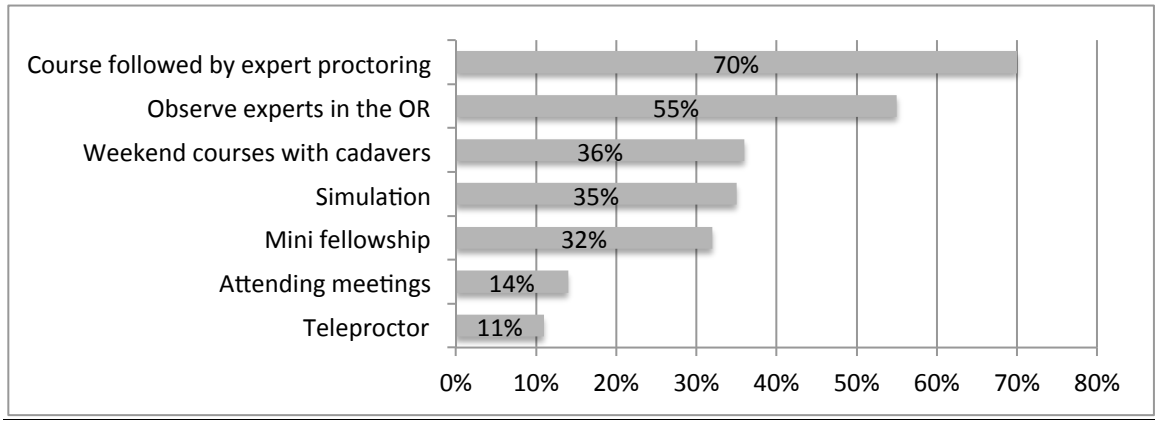


**Figure 2.** Preferred educational methods for surgeons who do not perform laparoscopic repair but want to learn (n=74). Respondents could choose more than one method.



## 6. ADDITIONAL RESULTS FROM SURVEY DATA

A large portion of the survey respondents was from Quebec. The following is a brief summary of their responses.

Of the 490 total members of the Quebec Surgical Association, 196 surgeons who practice hernia repairs responded to the survey. Sixty percent of responding surgeons never perform laparoscopic repair. The majority of respondents preferred an open approach with mesh for all 11 clinical scenarios including patients with bilateral (51%) and recurrent (55%) hernias, and female patients (63%). Among surgeons who never perform LIHR, 73% consider the benefits to be minimal, 59% say they lack the requisite training, and 53% want to avoid the use of general anesthesia. Among surgeons who lack the training, 21% are interested in learning. The preferred educational methods would be to observe experts in the operating room (61%) and a course followed by expert proctoring (58%).

## 7. SUMMARY AND CONCLUSIONS

The review and the survey both paint a picture of the current practices of inguinal hernia repair among general surgeons. Both studies confirm a low utilization of LIHR, as half of Quebec's surgeons and half of the surgeons who responded to the survey never perform it. LIHR is a highly specialized procedure and most of the province's cases were performed by a small group of eleven surgeons who performed over 100 cases each. Combining the results from the two studies, we found that surgeons with MIS fellowships and surgeons working in high volume centers are more likely to perform LIHR. We initially hypothesized that younger surgeons would be more likely to perform LIHR as laparoscopy is now more widespread in residency training. The survey showed this to be true, but the review showed the opposite as surgeons with more years of experience performed more laparoscopic repairs.

Both studies also give insight as to what is being done for patients with different hernia types and characteristics. Evidence-based guidelines provide surgeons with direction as to the ideal surgical approach for each patient, but little was known about what is being practiced in the real world. In Quebec, the majority of surgeons used an open approach regardless of the clinical scenario. The international group of survey respondents appeared more in favor of laparoscopy for certain cases. 18% of survey respondents use a laparoscopic approach to repair the majority of primary and unilateral hernias, and 9.8% of Quebec's patients with a primary and unilateral hernia received laparoscopic surgery. A laparoscopic approach was more popular for bilateral hernias in the survey (48%) and in the

review (28%). Guidelines strongly suggest a laparoscopic approach for females and for recurrent hernias after previous open repair. Trials have shown clear benefits for both of these scenarios. 54% of surveyed surgeons prefer LIHR for recurrent hernias, but only 10% of patients in Quebec with recurrent hernias underwent a laparoscopic surgery. For female patients, LIHR is not the procedure of choice among responding surgeons (21%), nor was it commonly used in Quebec (7%). There appears to be a discrepancy between what the surgeons said they would do in the survey and what is being done in actual practice. Perhaps surgeons are aware of the guidelines, but they are not following them for other reasons.

The survey revealed that the main barriers to implementation include a belief that the benefits of laparoscopy are minimal, and a lack of training due to the learning curve. Surgeons appear to be divided on the benefits of LIHR. The very few surgeons who performed over 100 laparoscopic repairs in Quebec used this technique for a large proportion of their cases. Evidently, these surgeons are seeing clear benefits that the others are not. Perhaps a large volume of cases is needed to overcome the learning curve in order to distinguish these benefits. There is no doubt that LIHR is a difficult operation and many cases are required to minimize complications and recurrences. However, there are surgeons who have the volume to overcome the learning curve but do not know how to perform the operation. The survey revealed that a quarter of surgeons who never perform LIHR want to learn. This reveals a knowledge gap that needs to be addressed so that these surgeons would be able to offer a laparoscopic approach for cases when it is recommended.

Staff and residents agreed that all graduating residents should be competent in this technique, but 65% of staff and 46% of residents said the graduates are not currently competent. Alarmingly, the first study showed that of the 11 expert surgeons who performed over 100 laparoscopic cases, only 5 are working in urban areas where the academic centers are located. Residents will not be able to become competent in this technique upon graduation if they are not adequately exposed. There is clearly a desire among certain staff and residents to learn LIHR, but they are not given the resources to do so. Surgeons and residents both agreed that the best educational method would be a course followed by expert proctoring. Residency programs need to improve their curriculum for LIHR, and training programs need to be created for staff surgeons who want to learn.

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## 9. APPENDICES

**Appendix A** – RAMQ codes and their classification of hernia types

| RAMQ Code(s) | Unilateral (0)<br>Bilateral (1) | Primary (0)<br>Recurrent (1) | Not incarcerated (0)<br>Incarcerated w/o resection (1)<br>Incarcerated w/ resection (2) |
|---|---|---|---|
| 5054 | 0 | 1 | 0 |
| 5054+5054 | 1 | 1 | 0 |
| 5054+5054+5459 | 1 | 1 | 1 |
| 5054+5455 | 1 | 1 | 0 |
| 5054+5456 | 1 | 1 | 0 |
| 5054+5457 | 1 | 1 | 0 |
| 5054+5459 | 0 | 1 | 1 |
| 5054+5468 | 1 | 1 | 0 |
| 5455 | 0 | 0 | 0 |
| 5455+5455 | 1 | 0 | 0 |
| 5455+5457 | 1 | 0 | 0 |
| 5455+5459 | 1 | 0 | 1 |
| 5455+5460 | 1 | 0 | 2 |
| 5455+5460+5460 | 1 | 0 | 2 |
| 5456 | 0 | 0 | 0 |
| 5457 | 1 | 0 | 0 |
| 5457+5457 | 1 | 0 | 0 |
| 5457+5459 | 1 | 0 | 1 |
| 5459 | 0 | 0 | 1 |
| 5459+5459 | 1 | 0 | 1 |
| 5460 | 0 | 0 | 2 |
| 5460+5460 | 1 | 0 | 2 |
| 5468 | 0 | 0 | 0 |

**Appendix B** – Comorbidities identified in the RAMQ (ICD-9 codes) and MED-ECHO (ICD-10 codes) databases, along with their CCI weights.

| Condition | Weight | ICD-9 | ICD-10 |
|---|---|---|---|
| MI | 1 | 410, 4109, 412, 4129 | I210, I212, I213, I214, I2140, I2141, I2142, I219, I220, I221, I228, I229, I252 |
| CHF | 1 | 4280, 4281, 4289 | I500, I501, I509, I099 |
| PVD | 1 | 4410, 4411, 4412, 4413, 4414, 4415, 4416, 4417, 4439, 7854, V434 | I710, I711, I712, I713, I714, I715, I716, I718, I719, I739, I739, R02, R7958, Z959 |
| CVD | 1 | 430, 4309, 431, 4319, 432, 4320, 4321, 4329, 433, 4330, 4331, 4332, 4333, 4338, 4339, 4340, 4341, 4348, 4349, 4349, 435, 436, 4369, 4332, 4353, 4358, 4359, 436, 4369, 4370, 4371, 4372, 4373, 4374, 4375, 4376, 4377, 4378, 4379, 438, 4380, 4381, 4389 | I601, I602, I603, I604, I605, I606, I607, I608, I609, I610, I619, I620, I621, I629, I630, I631, I632, I633, I634, I635, I636, I638, I639, I64, I650, I651, I652, I653, I658, I659, I660, I661, I663, I663, I664, I668, I669, I670, I671, I672, I674, I675, I676, I677, I678, I679, I681, I682, I688, I690, I691, I692, I693, I694, I698, G450, G451, G452, G458, G459, G460, G461, G462, G463, G464, G465, G566, G46 |
| Dementia | 1 | 290, 2900, 2901, 2903, 2904, 2908, 2909, 2941 | F00, F001, F002, F003, F009, F010, F011, F012, F013, F018, F019, F020, F021, F022, F023, F024, F028, F051, F03 |
| CPD | 1 | 490, 4910, 4911, 4918, 4919, 492, 4929, 496, 4969, 4912, 4930, 4931, 4939, 494, 4949, 500, 5009, 501, 5019, 502, 5029, 503, 5039, 505, 5059 | J40, J410, J411, J418, J42, J430, J431, J432, J438, J439, J440, J441, J418, J449, J450, J4500, J4501, J4510, J4511, J4580, J4581, J4590, J4591, J47, J60, J61, J620, J628, J630, J631, J632, J633, J634, J635, J638, J64, J65 |
| Rheumatoid Disease | 1 | 7100, 7101, 7104, 7140, 7141, 7142, 7148, 725 | M320, M321, M328, M329, M332, M340, M341, M342, M348, M349, M050, M051, M052, M053, M058, M059, M060 |
| Peptic ulcer | 1 | 531, 5310, 5311, 5312, 5313, 5314, 5315, 5316, 5317, 5319, 532, 5320, 5321, 5322, 5323, 5324, 5325, 5326, 5327, 5329, 533, 5330, 5331, 5332, 5333, 5334, 5335, 5336, 5337, 5339, 534, 5340, 5341, 5342, 5343, 5344, 5345, 5346, 5347, 5349 | K250, K251, K252, K253, K254, K255, K256, K257, K259, K260, K261, K262, K263, K264, K265, K266, K267, K268, K269, K270, K271, K272, K273, K274, K275, K276, K277, K279, K280, K281, K282, K283, K284, K285, K286, K287, K289 |
| Mild Liver Disease | 1 | 5712, 5714, 5715, 5716 | K702, K703, K730, K731, K732, K738, K739, K740, K742, K743, K744, K745, K746, K717 |
| Moderate or severe liver disease | 3 | 5728, 5722, 5723, 5724 | K729, K766, K767, K721 |
| Diabetes w/o complications | 1 | 250, 2500, 2501 | E109, E119, E139, E1010, E1011, E1012, E1110, E1111, E1112, E1310, E311, E312, E410, E1411, E1412 |

| | | | |
|---|---|---|---|
| Diabetes w/ complications | 2 | 2503, 2504, 2505, 2506, 2507 | E1330, E1331, E1332, E1333, E1335, E1336, E1338, E1340, E1341, E1342, E1350, E1351, E1352, E1020, E1021, E1022, E1023, E1028, E1030, E1032, E1033, E1035, E1036, E1038, E1040, E1041, E1041, E1050, E1051, E1060, E1061, E1062, E1063, E1064, E1068, E1070, E1071, E1078, E1120, E1121, E1122, E1123, E1128, E1130, E1131, E1132, E1133, E1134, E1135, E1136, E1138, E1140, E1141, E1142, E1150, E1151, E1152, E1160, E1161, E1162, E1163, E1164, E1168, E1170, E1171, E1178, E1320, E1321, E1322, E1323, E1328, E1360, E1361, E1362, E1363, E1364, E1368,E1370, E1371, E1378, E1420, E1421, E1422, E1423, E1428, E1430, E1431, E1432, E1433, E1435, E1436, E1438, E1440, E1441, E1442, E1450, E1451, E1452, E1460, E1461, E1462, E1463, E1464, E1468, E1470, E1471, E1478 |
| Paraplegia | 2 | 3420, 3421, 3429, 3442 | G8100, G8101, G8109, G8110, G8111, G8119, G8190, G8191, G8199, G041, G820, G821, G822, G823, G82021, G82022, G82023, G82021, G82022, G82023, G82091, G82092, G82093, G82111, G82112, G82113, G82121, G82122, G82123, G82191, G82192, G82193, G82211, G82212, G82213, G82221, G82222, G82223, G82291, G82292, G82293 |
| Renal Disease | 2 | 5820, 5821, 5822, 5828, 5830, 5831, 5832, 585, 5859, 586, 5869, 5880, 5881, 5888, 5858 | N030, N031, N032, N033, N034, N035, N036, N037, N038, N039, N052, N053, N054, N055, N056, N072, N073, N074, N010, N011, N012, N013, N014, N015, N016, N017, N018, N019, N180, N181, N182, N183, N184, N185, N188, N189, N19, N250, N251, N258, N259 |
| Cancer | 2 | 1410, 1411, 1412, 1413, 1414, 1415, 1416, 1418, 1419, 142, 1420, 1421, 1422, 1428, 1429, 143, 1430, 1431, 1439, 1440, 1441, 1448, 1449, 1450, 1451, 1452, 1453, 1454, 1455, 1456, 1458, 1459, 1460, 1461, 1462, 1463, 1464, 1465, 1466, 1467, 1468, 1469, 1470, 1471, 1472, 1473, 1478, 1479, 1480, 1481, 1482, 1483, 1488, 1489, 149, 1490, 1491, 1498, 150, 1500, 1501, 1502, 1503, 1504, 1505, 1508, 1509, 151, 1510, 1511, | C01, C020, C021, C022, C023, C024, C029, C030, C031, C039, C040, C041, C048, C049, C050, C051, C052, C058, C059, C060, C061, C062, C068, C069, C07, C080, C081, C088, C089, C090, C091, C098, C099, C100, C101, C102, C103, C104, C108, C109, C110, C111, C112, C113, C118, C119, C12, C130, C131, C132, C138, C139, C140, C142, C148, C150, C151, C152, C153, C154, C155, C158, C159, C160, C161, C162, C163, C164, C165, C166, C168, C169, C170, C171, C172, C173, C178, C179, C180, C181, C182, C183, C184, C185, |

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| | | 1512, 1513, 1514, 1515, 1516, 1518, 1519, 152, 1520, 1521, 1522, 1523, 1528, 1529, 153, 1530, 1531, 1532, 1533, 1534, 1535, 1536, 1537, 1538, 1539, 154, 1540, 1541, 1542, 1543, 1548, 155, 1550, 1551, 1552, 156, 1560, 1561, 1562, 1568, 1569, 157, 1570, 1571, 1572, 1573, 1574, 1578, 1579, 1580, 1589, 159, 1590, 1591, 1598, 1599, 160, 1600, 1601, 1602, 1603, 1604, 1605, 1608, 1609, 161, 1610, 1611, 1612, 1613, 1618, 1619, 1620, 1622, 1623, 1624, 1625, 1628, 1629, 163, 1630, 1631, 1638, 1639, 164, 1640, 1641, 1642, 1643, 1648, 1649, 165, 1650, 1658, 1659, 170, 1700, 1701, 1702, 1703, 1704, 1705, 1706, 1707, 1708, 1709, 171, 1710, 1712, 1713, 1714, 1715, 1716, 1717, 1718, 1719, 1739, 1740, 1741, 1742, 1743, 1744, 1745, 1746, 1748, 1749, 179, 1799, 180, 1800, 1801, 1808, 1809, 181, 1819, 182, 1820, 1828, 183, 1830, 1832, 1833, 1834, 1835, 1838, 839, 184, 1840, 1841, 1842, 1843, 1844, 1848, 1849, 185, 186, 1860, 1861, 1862, 186, 1864, 1865, 1866, 1867, 1868, 1869, 187, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879, 188, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1889, 189, 1890, 1891, 1892, 1893, 1894, 1898, 1899, 190, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909, 191, 1910, 1911, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 192, 1920, 1921, 1922, 1923, 1928, 1929, 193, 1939, 194, 1940, 1941, 1943, 1944, 1945, 1946, 1948, 1949, 195, 1950, 1951, 1952, 1953, 1954, 1955, 1958, 200, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 201, 2010, 2011, 2012, 2014, 2015, 2016, 2017, 2019, 202, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 203, 2030, | C186, C187, C188, C189, C19, C20, C210, C211, C212, C218, C220, C221, C222, C223, C224, C227, C229, C230, C240, C241, C248, C249, C250, C251, C253, C254, C257, C258, C259, C260, C261, C268, C269, C3000, C3001, C301, C310, C33, C3400, C3401, C3409, C3410, C3411, C3419, C342, C3430, C3431, C3439, C3480, C3490, C3491, C3499, C37, C380, C381, C382, C383, C384, C388, C390, C398, C399, C430, C431, C432, C433, C434, C435, C436, C437, C438, C439, C450, C451, C452, C457, C459, C400, C401, C401, C403, C408, C409, C4100, C4101, C411, C412, C413, C414, C418, C419, C460, C461, C462, C463, C4670, C4671, C4678, C468, C469, C470, C471, C472, C473, C474, C475, C476, C477, C478, C479, C480, C481, C482, C488, C490, C491, C492, C493, C494, C495, C496, C498, C499, C500, C501, C509, C5010, C5011, C5019, C5030, C5031, C5039, C5040, C5041, C5049, C5050, C5051, C5059, C5060, C5061, C5069, C5080, C5081, C5089, C5090, C5091, C5099, C510, C511, C512, C518, C519, C520, C530, C531, C538, C539, C540, C541, C542, C543, C548, C549, C55, C560, C561, C569, C6210, C6211, C6219, C6290, C6291, C6299, C630, C5631, C5632, C637, C638, C639, C64, C65, C66, C670, C671, C672, C673, C674, C675, C676, C677, C678, C679, C80, C681, C688, C689, C690, C691, C692, C693, C694, C695, C696, C697, C698, C699, C701, C702, C703, C704, C705, C706, C707, C708, C709, C6710, C711, C712, C713, C714, C715, C716, C717, C718, C719, C720, C6721, C722, C723, C724, C725, C726, C727, C728, C729, C73, C810, C811, C812, C813, C817, C819, C820, C821, C822, C827, C829, C830, C831, C832, C833, C834, C835, C836, C837, C838, C839, C840, C841, C844, C845, C851, C857, C859, C883, C887, C889, C900, C901, C9020, C9021, C910, C911, C913, C914, C915, C917, C919, C920, C921, C923, C924, C925, C927, C929, C930, C937, C939, C940, C942, C943, C947, C950, C951, C957, C959, C960, C961, C962, C963, C967, C969" |

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| | | 2031, 2038, 204, 2040, 2041, 2049, 2050, 2051, 2053, 2058, 2059, 2060, 2068, 2069, 2070, 2072, 2078, 2080, 2081, 2088, 2089, | |
| Metastatic cancer | 6 | 196, 1960, 1961, 1962, 1963, 1965, 1966, 1968, 1969, 197, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 198, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 199, 1990, 1991 | C770, C771, C772, C773, C774, C775, C778, C779, C780, C781, C782, C783, C784, C785, C786, C787, C788, C790, C791, C792, C793, C794, C795, C796, C797, C7980, C7988, C799, C80, C800, C809 |
| HIV | 6 | 42, 43, 44, 428 | B20, B21, B22, B23, B24 |

**Appendix C** – Other surgical procedures identified in the RAMQ database by body region (abdomen = 1, genitals = 2, pelvis = 3, other = 4)

| RAMQ Code | Description | Region |
|---|---|---|
| 1013 | ABCÈS, HÉMATOME OU SÉROME, UNIQUE OU MULTIPLE sans anesthésie ou sous anesthésie locale sous-cutané, panaris ou fenestration d'un ongle | 4 |
| 1016 | ABCÈS, HÉMATOME OU SÉROME, UNIQUE OU MULTIPLE sans anesthésie ou sous anesthésie locale: intramusculaire | 4 |
| 1017 | ABCÈS, HÉMATOME OU SÉROME, UNIQUE OU MULTIPLE sous anesthésie régionale ou générale: sous-cutané | 4 |
| 1020 | ABCÈS, HÉMATOME OU SÉROME, UNIQUE OU MULTIPLE sous anesthésie régionale ou générale: intramusculaire | 4 |
| 1021 | LIPECTOMIE FONCTIONNELLE Excision du membre inférieur | 4 |
| 1101 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Face, cou et organes génitaux- sans anesthésie ou avec anesthésie locale sans suture | 4 |
| 1102 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Face, cou et organes génitaux- sans anesthésie ou avec anesthésie locale avec suture- 2cm ou moins | 4 |
| 1103 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Face, cou et organes génitaux- sans anesthésie ou avec anesthésie locale avec suture- 2 a 5 cm | 4 |
| 1105 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Face, cou et organes génitaux- sous anesthésie régionale ou générale avec suture- 2cm ou moins | 4 |
| 1106 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Face, cou et organes génitaux- sous anesthésie régionale ou générale avec suture- 2 a 5 cm | 4 |
| 1107 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Face, cou et organes génitaux- sous anesthésie régionale ou générale avec suture- plus de 5cm | 4 |
| 1108 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Autre région- sans anesthésie ou avec anesthésie locale sans suture- 5cm ou moins | 4 |
| 1109 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Autre région- sans anesthésie ou avec anesthésie locale avec suture- plus de 5cm | 4 |
| 1121 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Autre région- sans anesthésie ou avec anesthésie locale avec suture- 5cm ou moins | 4 |
| 1122 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Autre région- sans anesthésie ou avec anesthésie locale avec suture- plus de 5 cm | 4 |
| 1123 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Autre région- sous anesthésie régionale ou générale- 5cm ou moins- 5cm ou moins | 4 |
| 1124 | Excision conventionnelle, au laser ou par cryochirurgie TUMEUR BÉNIGNE OU PRÉCANCÉREUSE Autre région- sous anesthésie régionale ou générale- plus de 5cm - plus de 5cm | 4 |
| 1131 | Exérèse d'un mélanome Face, cou et organes génitaux sous anesthésie locale | 4 |
| 1132 | Exérèse d'un mélanome Face, cou et organes génitaux sous anesthésie régionale ou générale | 4 |
| 1133 | Exérèse d'un mélanome Autre région sous anesthésie locale | 4 |
| 1134 | Exérèse d'un mélanome Autre région sous anesthésie régionale ou générale | 4 |
| 1169 | Kystes sébacés: face, cuir chevelu, cou | 4 |
| 1172 | Kystes sébacés: autres localisations | 4 |
| 1196 | Exérèse de corps étrangers: simple | 4 |
| 1201 | Seins: Biopsie ouverte unique ou multiple | 4 |
| 1205 | Seins: Tumorectomie ou mastectomie partielle | 4 |

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| 1215 | Onycectomie, doigt ou orteil | 4 |
| 1216 | Onycectomie, doigt ou orteil | 4 |
| 1217 | Sinus pilonidal (kyste sacro-coccygien) | 4 |
| 1221 | Sinus pilonidal (kyste sacro-coccygien) | 4 |
| 1222 | Verrue Excision chirurgicale: non faciale | 4 |
| 1223 | Verrue Excision chirurgicale: faciale | 4 |
| 1225 | Verrue Excision chirurgicale: plantaire | 4 |
| 1228 | Seins: Excision bénigne ou maligne | 4 |
| 1233 | Brûlures: étendues | 4 |
| 1323 | Réparation de plaies (wound) moin de 1cm | 4 |
| 1328 | réparation de plaie opératoire pour hémorragie | 4 |
| 1365 | Greffes par glissement, rotation ou transposition | 4 |
| 1414 | Exérèse de fistule cutanée superficielle susaponévrotique | 4 |
| 1423 | Greffe libre | 4 |
| 1432 | Exérèse des glandes sudoripares pour hyperhidrose ou pour hidrosadénite suppurée | 4 |
| 2014 | exploration d'un tendon, d'une gaine tendineuse, drainage ou section de gaine ou exérèse de corps étranger | 4 |
| 2015 | exploration de fascia, ligament et/ou exploration de nodule et/ou exérèse de corps étranger | 4 |
| 2082 | exérèse de tumeur bénigne, tendon, gaine, ligament, fsacia | 4 |
| 2083 | exérèse de tumeur maligne, tendon, gaine, ligament, fascia | 4 |
| 2125 | fasciectomie palmaire: pour maladie de Dupuytren | 4 |
| 2126 | fasciectomie digitale: pour maladie de Dupuytren | 4 |
| 2152 | muscles: excision tumeur bénigne | 4 |
| 2153 | muscles: excision tumeur maligne | 4 |
| 2190 | muscles: exérèse d'un corps étranger sous anesthésie générale | 4 |
| 2213 | Mise en place d'un fixateur externe vertébral par approche percutanée | 4 |
| 2304 | Exérèse: de vis, clou, broches, fils, plaque | 4 |
| 2383 | Décompression tunnel carpien | 4 |
| 2553 | pied bot ou astragale vertical: allongement ouvert du tendon d'Achille | 4 |
| 2724 | Arthroscopie simple | 4 |
| 2750 | Ténotomie corrective | 4 |
| 2897 | Greffe osseuse ou cartilagineuse | 4 |
| 3027 | Médiastinotomie antérieure | 4 |
| 3039 | Laryngoscopie incluant la biopsie | 4 |
| 3040 | Laryngoscopie incluant la biopsie | 4 |
| 3041 | Laryngoscopie incluant la biopsie | 4 |
| 4159 | Exérèse de ganglions cervicaux (bénin ou malin) | 4 |
| 4161 | Excision simple de ganglions lymphatiques pour lésion maligne | 4 |
| 4162 | Excision simple de ganglions lymphatiques pour lésion bénigne | 4 |
| 4199 | Exérèse d'un ou plusieurs ganglion(s) sentinelle(s) | 4 |
| 4235 | Splénectomie | 1 |
| 4243 | Évidement des ganglions lymphatiques : région inguinale superficielle | 2 |
| 4244 | Évidement des ganglions lymphatiques : région illiaque et inguinale superficielle et profonde | 2 |
| 4248 | Biopsie des ganglions aortiques | 1 |
| 4280 | Biopsies étagées ou lymphadénectomie radicale du petit bassin ou les deux | 3 |
| 4516 | Circulation assistée: Emploi de l'autotransfusion à l'aide d'appareillage spécialisé de type « Cell Saver » | 4 |
| 4666 | Chirurgie exploratoire d'une artère majeure au niveau d'une extrémité | 4 |
| 4668 | Réparation d'anévrisme: d'une aorte abdominale ou aorto-illiaque ou périphérique | 1 |
| 4669 | Réparation d'anévrisme: anévrisme rupturé ou disséquant, | 1 |
| 4689 | Réintervention artérielle au même site | 4 |
| 4693 | Thrombo-endartérectomie et/ou angioplastie ouverte et/ou pontage d'une artère abdominale Aorto-aortique | 1 |
| 4695 | Thrombo-endartérectomie et/ou angioplastie ouverte et/ou pontage d'une artère abdominale Aorto: iliaque bilateral | 1 |
| 4697 | Thrombo-endartérectomie et/ou angioplastie ouverte et/ou pontage d'une artère abdominale: Aorto-femoral | 1 |
| 4698 | Thrombo-endartérectomie et/ou angioplastie ouverte et/ou pontage | 1 |

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| | d’une artère abdominale | |
| 4701 | Thrombo-endartérectomie et/ou angioplastie ouverte et/ou pontage d’une artère abdominale | 1 |
| 4721 | Pontage d’une artère périphérique | 4 |
| 4733 | Pontage: fémoro-fémoral | 4 |
| 4762 | Réparation d’une artère ou d’une veine abdominale ou de la jugulaire interne ou de la carotide | 1 |
| 4770 | pontage (prothèse) | 4 |
| 4782 | Ligature et/ou section de la crosse de la saphène interne et de ses branches | 4 |
| 4784 | Ligature, section et exérèse au complet des veines saphènes internes ou externes | 4 |
| 4791 | Dissection et excision de paquets variqueux ou ligature de perforantes ou les deux, par membre | 4 |
| 4792 | Dissection et excision de paquets variqueux ou ligature de perforantes ou les deux, par membre | 4 |
| 4826 | Implantation d’électrode(s) et de générateur pour stimulateur cardiaque permanent | 4 |
| 4829 | Implantation d’électrode(s) et de générateur pour stimulateur cardiaque permanent: repositionnement | 4 |
| 5010 | Laparoscopie diagnostique | 1 |
| 5011 | Laparoscopie diagnostique lors d'une autre intervention chirurgicale, supplément | 1 |
| 5027 | Iléostomie | 1 |
| 5044 | ouverture et drainage d'un abcès de la fosse ischiorectale de l'espace pelvi-rectal supérieur ou de la loge rétrorectale. | 1 |
| 5050 | Fistulotomie extrasphinctérienne | 4 |
| 5052 | Sphinctérotomie | 4 |
| 5056 | Cholécystotomie ou cholécystostomie | 1 |
| 5059 | Hépatotomie: drainage d'abces ou kyste | 1 |
| 5066 | Excision de lésion bénigne de la langue | 4 |
| 5077 | Laparotomie avec ou sans biopsie | 1 |
| 5080 | Abcès péritonéal | 1 |
| 5093 | Excision: Tumeur desmoïde ou rétropéritonéale | 1 |
| 5108 | Endoscopie de l'intestin lors d'une laparotomie | 1 |
| 5110 | exérèse de diverticule de Meckel | 1 |
| 5121 | Excision: Diverticule de Meckel | 1 |
| 5124 | Résection du palais ou exérèse d'une lésion étendue du palais | 4 |
| 5136 | résection intestin grêle ou côlon avec iléostomie | 1 |
| 5140 | Résection intestinale avec anastomose grêle | 1 |
| 5141 | Résection intestinale avec anastomose iléon terminal, caecum | 1 |
| 5142 | Résection intestinale avec anastomose iléon terminal, caecum, côlon ascendant et angle hépatique | 1 |
| 5144 | Excision de peau périanale (languette) et/ou de marisque | 4 |
| 5148 | Biopsie hépatique incisionnelle ou à l'aiguille au cours de toute laparotomie | 1 |
| 5152 | Résection intestinale avec anastomose | 1 |
| 5154 | Résection intestinale avec anastomose côlon transverse ou segment du côlon gauche | 1 |
| 5164 | hémicolectomie gauche | 1 |
| 5165 | résection partielle du côlon avec colostomie et fermeture du rectum distal | 1 |
| 5166 | résection totale du côlon avec iléostomie et fermeture du rectum distal | 1 |
| 5182 | Exérèse d'une tumeur villeuse du rectum par voie anale | 4 |
| 5183 | Exérèse par voie périnéale ou abdominale d'une tumeur maligne du rectum | 1 |
| 5186 | Anus: Excision locale pour lésion maligne | 4 |
| 5196 | Pancreas: Sutures infectées sous anesthésie générale et révision de toute la plaie | 1 |
| 5197 | Kyste du mésentère avec laparotomie | 1 |
| 5201 | Appendicectomie, toute voie d'approche | 1 |
| 5209 | Appendicectomie toute voie d'approche + exérèse de diverticule de Meckel | 1 |
| 5231 | Résection intestinale avec anastomose segment du côlon non contigu | 1 |

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| 5238 | Iléostomie ou jéjunostomie lors d'une autre chirurgie | 1 |
| 5240 | Protectomie | 1 |
| 5241 | Protectomie | 1 |
| 5247 | anus - excision ligature d'hemorroides selon la technique de mcgivney, barron et al avec ou sans anuscopie, par séance si rectosigmoidoscopie, supplement (prise d'effet du supplement le 1er avril 1994) | 4 |
| 5248 | Hémorroïdectomie | 4 |
| 5249 | Hémorroïdectomie | 4 |
| 5259 | Excision de l'ampoule de Vater | 1 |
| 5269 | Cholécystectomie, toute voie d'approche | 1 |
| 5324 | Reconstruction labiale totale | 2 |
| 5376 | Gastrorraphie ou duodénorraphie (pour ulcère perforé ou plaie) | 1 |
| 5383 | Reprise de colostomie, en profondeur | 1 |
| 5384 | Intubation du grêle, avec ou sans scopie: occlusion intestinale | 1 |
| 5386 | Intubation du grêle, avec ou sans scopie: occlusion intestinale | 1 |
| 5387 | Suture intestinale au cours d'une autre intervention | 1 |
| 5389 | Réparation: Suture intestinale (lacération de part en part) | 1 |
| 5393 | Suture du mésentère post-traumatique | 1 |
| 5400 | Anastomose du rectum | 1 |
| 5404 | Prolapsus rectal excision de la muqueuse | 3 |
| 5411 | Suture du rectum (post-traumatique) approche intrapéritonéale | 3 |
| 5462 | Herniotomie ombilicale (incluant l'omphaloplastie) | 1 |
| 5469 | Hernie incisionnelle | 1 |
| 5471 | Hernie épigastrique | 1 |
| 5474 | Herniotomie ombilicale traitements subséquents | 1 |
| 5475 | Réparation d'éventration postopératoire | 1 |
| 5479 | Traitement de syndrome de compression du tronc coeliaque par ligament arqué | 1 |
| 5480 | Excision radicale ou partielle de tumeur maligne (type sarcome, tératome, neuroblastome) | 4 |
| 5488 | Herniotomie ombilicale cure de hernie de Spiegel | 1 |
| 5803 | Examen anorectal sous anesthésie générale ou régionale | |
| 6002 | cystoprostatectomie radicale | 3 |
| 6003 | Ouverture et drainage d'abcès périrénal | 1 |
| 6010 | Section ou résection du col vésical | 1 |
| 6017 | Cystostomie | 3 |
| 6020 | Cystostomie | 3 |
| 6021 | Réparation: Urétropexie | 3 |
| 6024 | Extraction ou tentative d’extraction d’un calcul ou de corps étranger de l’uretère par urétéroscopie rétrograde | 2 |
| 6032 | Méatotomie comportant la section du méat | 2 |
| 6035 | Sphinctérotomie (sphincter externe) | 2 |
| 6043 | Périnéotomie ou périnéorraphie ou hyménotomie | 2 |
| 6052 | exentération antérieure chez la femme pour remplacement vésical détubularisé avec anastomose urétrale | 2 |
| 6060 | Résection de tissu prostatique résiduel ou récidivant | 3 |
| 6061 | Résection de tissu prostatique résiduel ou récidivant | 3 |
| 6066 | Colpotomie (exploration et drainage) | 2 |
| 6101 | Néphrectomie partielle | 1 |
| 6106 | Résection partielle du scrotum | 2 |
| 6113 | Cystectomie partielle | 3 |
| 6119 | Amputation partielle du pénis, incluant segment d'urètre. | 2 |
| 6122 | Castration simple uni ou bilatérale | 2 |
| 6125 | Orchiectomie par voie inguinale | 2 |
| 6127 | Traitement pour pathologie du prépuce | 2 |
| 6131 | Excision ou fulguration ou les deux de lésions locales du pénis et/ou allongement du frein du prépuce | 2 |
| 6145 | Dilatation et curetage biopsique avec ou sans polypectomie ou cautérisation | 2 |
| 6152 | Hémithyroïdectomie (lobectomie) | 4 |
| 6156 | Vulvectomie | 2 |
| 6161 | Excision complète de tumeur rétropéritonéale | 1 |
| 6168 | Traitement chirurgical endoscopique (toute technique) de tumeur | 3 |

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| | maligne de la vessie | |
| 6170 | Ablation de tumeurs bénignes de la vulve | 2 |
| 6172 | Marsupialisation du kyste de Bartholin | 2 |
| 6185 | Excision Parathyroïde ou tumeurs de parathyroïde voie cervicale | 4 |
| 6188 | Excision Kyste ovarien, para-ovarien | 3 |
| 6191 | Chirurgie pour cancer gynécologique | 2 |
| 6194 | Excision convenionelle ou au laser avec lymphadénectomie radicale lombo-aortique à partir de l'origine des vaisseaux ovariens | 3 |
| 6199 | Néphrectomie partielle ou totale ou radicale, avec résection complète de l'uretère et de collerette vésicale | 1 |
| 6200 | Néphrectomie radicale avec évidement des tissus graisseux et lymphatiques périrénaux dans le cas de tumeur rénale | 1 |
| 6204 | Marsupialisation de kyste réna | 1 |
| 6212 | Prostatectomie | 3 |
| 6216 | Hystérectomie totale | 3 |
| 6218 | Amputation complète du pénis, incluant urétrostomie périnéale | 2 |
| 6221 | Transplantation rénale | 1 |
| 6224 | Hypospadias pénien | 2 |
| 6232 | Vasectomie unilatérale ou bilatérale | 2 |
| 6239 | Prostatectomie | 3 |
| 6241 | Prostatectomie rétropubienne simple | 3 |
| 6243 | Prostatectomie rétropubienne radicale incluant vésiculectomie | 3 |
| 6247 | Prostatectomie transurétrale | 3 |
| 6257 | Exploration pour torsion du testicule (fixation ou orchiectomie) ou de l'hydatide et fixation du testicule du côté opposé | 2 |
| 6260 | Salpingectomie ou salpingo-ovariectomie | 3 |
| 6261 | Ovariectomie unilatérale ou bilatérale | 3 |
| 6262 | Résection cunéiforme, unilatérale ou bilatérale | 3 |
| 6265 | Hystérectomie abdominale totale | 3 |
| 6266 | Hystérectomie vaginale totale | 3 |
| 6273 | Hystérectomie vaginale avec cystocèle, salpingo-ovariectomie incluse | 3 |
| 6274 | Hystérectomie vaginale avec rectocèle et cystocèle | 3 |
| 6285 | Orchidopexie | 2 |
| 6300 | Litholapaxie | 1 |
| 6301 | Litholapaxie : broyage d'un ou plusieurs calculs et extraction des fragments | 1 |
| 6303 | Ovariectomie bilaterale | 1 |
| 6305 | Anastomose urétéro-intestinale unilatérale | 3 |
| 6309 | Exploration inguinale pour masse testiculaire | 2 |
| 6333 | Anastomose urétéro-intestinale unilatérale | 3 |
| 6335 | Urétéro-néocystostomie | 3 |
| 6357 | Cystorraphie, pour rupture de la vessie | 3 |
| 6358 | Fermeture de cystostomie ou de fistule vésico-cutanée | 3 |
| 6362 | Urétropexie | 3 |
| 6389 | Traitement d'hydrocèle ou spermatocèle par injection de substance sclérosante | 2 |
| 6390 | Exérèse chirurgicale totale ou partielle de l'épididyme, de spermatocèle, d'hydrocèle, d'hématocèle, de kyste du cordon | 2 |
| 6391 | Exploration abdominale ou inguinale ou les deux | 2 |
| 6393 | Cure d'hydrocèle ou d'hématocèle | 2 |
| 6394 | Ouverture et drainage d'abcès intra-scrotal ou d'un hématocèle | 2 |
| 6397 | Exérèse de varicocèle unilatérale | 2 |
| 6406 | Réparation: Cystocèle et rectocèle | 2 |
| 6412 | Urétropexie sus-pubienne | 2 |
| 6414 | Entérocèle ou colpocèle par voie vaginale | 2 |
| 6420 | Colpo-sacropexie, avec ou sans bande | 1 |
| 6425 | Réparation Cystocèle et/ou rectocèle et/ou entérocèle | 3 |
| 6426 | Réparation Sacro-ischiopexie par voie vaginale | 2 |
| 6427 | Cure primaire de prolapsus génital avec installation de tissu synthétique ou biocompatible | 2 |
| 6428 | Salpingostomie ou réanastomose sous microscope | 2 |
| 6429 | Stérilisation, toute méthode, toute voie d'approche, unilatérale ou bilatérale, post-partum ou élective | 3 |

| | | |
|---|---|---|
| 6434 | Hystéroscopie | 2 |
| 6444 | Vaso-vasostomie unilatérale par microchirurgie | 2 |
| 6460 | Hystéroscopie avec ablation ou résection de l'endomètre ou myomectomie de moins de 3 cm | 2 |
| 6912 | Césarienne | 3 |
| 6946 | Césarienne | 3 |
| 7078 | Paracentèse unilatérale | 4 |
| 7174 | Excision de tumeur bénigne ou maligne | 4 |
| 7261 | Cataracte, incluant les iridectomies | 4 |
| 7333 | Exploration d'un nerf mineur avec ou sans neurolyse | 4 |
| 7674 | Thermocoagulation ou infiltration intracrânienne du trijumeau | 4 |
| 7772 | Décompression-neurolyse du nerf cubital au coude, avec ostéotomie de l'épitrochlée humérale | 4 |
| 7792 | Neurolyse d'un nerf majeur | 4 |
| 7799 | Suture nerveuse (neurorraphie) | 4 |
| 7803 | Cornée Curetage et/ou cautérisation | 4 |
| 7806 | Incision relaxante pour corrections d'astigmatisme sous anesthésie locale | 4 |
| 9537 | Excision: kyste arthrosynovial ou ténosynovial | 4 |
| 9589 | Fracture: enclouage centromédullaire avec clou long | 4 |
| 9590 | Fracture: verrouillage distal une vis ou plus | 4 |
| 18082 | Fracture: Reduction ouverte | 4 |

**Appendix D** – Survey

Demographics

1. Gender
    a) Female
    b) Male

2. Age
    a) 20-29
    b) 30-39
    c) 40-49
    d) 50-59
    e) 60+

3. Country
    a) Canada
    b) United States
    c) Other – Please specify

3. Practice setting
    a) University/Academic hospital
    b) Community hospital, university affiliated
    c) Urban community hospital not affiliated with university
    d) Rural community hospital not affiliated with university
    e) Outpatient surgery center
    f) Other: please specify_____

4. Number of years in practice
    A) I am a resident
    B) 0 - 5
    C) 6 - 10
    D) 11 - 15
    E) 16 - 20
    F) 21+

5. Do you have a fellowship in minimally invasive surgery?

A) Yes
B) No

6. Are you a member of any of the following societies?
A) Society of American Gastrointestinal and Endoscopic Surgeons (SAGES)
B) American College of Surgeons
C) Canadian Association of General Surgeons
D) Society for Surgery of the Alimentary Tract
E) American Hernia Society
F) American Society for Metabolic and Bariatric Surgery

Utilization of Techniques

1. The majority of primary unilateral inguinal hernias in your practice are repaired:

A) Laparoscopically
B) Open
C) Both equally

2. Among the laparoscopic inguinal hernias that you perform, most are:

A) TEP
B) TAPP
C) Both equally
D) I do not perform laparoscopic repair

3. The majority of primary inguinal hernias in your practice are repaired using:

A) Mesh
B) No Mesh
C) Both equally

4. Average number of OPEN inguinal hernia repairs performed per year?

A) 0
B) 1-20
C) 21-50
D) 51-100
E) Over 100

5. Average number of laparoscopic inguinal hernia repairs (LIHR) performed per year? (include both TEP and TAPP)

A) 0
B) 1-20
C) 21-50

D) 51-100
E) Over 100

Clinical Scenarios

*Understanding that there is limited information available, and no opportunity to discuss the options with the patient, based on what is in the vignette, how would you treat the following patients in your own practice?*

*Answer choices included: Watchful waiting, open mesh, open no mesh, TEP, TAPP, and other.*

1. A 35 year old female with a moderate-sized symptomatic, unilateral, reducible inguinal hernia.

2. A 22 year old active male with a small asymptomatic unilateral, reducible inguinal hernia.

3. A healthy 65 year old male with symptomatic, bilateral, reducible, inguinal hernias.

4. A 66 year old male with a symptomatic recurrent right inguinal hernia after previous open mesh repair.

5. A 45 year old male who does very physical work with a recurrent, left inguinal hernia after previous TEP repair.

6. A 30 year old male office worker with a painful, unilateral, recurrent inguinal hernia after previous TAPP repair.

7. A 70 year old male with a symptomatic, scrotal, incarcerated, non-obstructing unilateral inguinal hernia.

8. A 70 year old male with an incarcerated, acutely obstructing unilateral inguinal hernia that cannot be reduced with conscious sedation.

9. A 60 year old male with severe COPD with a symptomatic, unilateral inguinal hernia.

10. A 70 year old male with a previous open prostatectomy with a symptomatic unilateral, reducible inguinal hernia.

11. A 50 year old male with a recurrent right inguinal hernia after previous TEP repair and a left primary inguinal hernia - both symptomatic.

**Education**

1. What are some of the barriers to adoption of laparoscopic inguinal hernia repair in your own environment? (Choose all that apply)

a. Increased recurrence rates
b. Increased complications
c. Increased costs
d. Increased OR time
e. Lack of training and experience (learning curve)
f. Requires general anesthesia
g. Requires use of mesh
h. Inadequate support from administration
i. Patient preference
j. Benefits of laparoscopy are minimal
k. other

2. In your opinion, what are some of the barriers to adoption of laparoscopic inguinal hernia surgery for surgeons overall? (Choose all that apply)

a. Increased recurrence rates
b. Increased complications
c. Increased costs
d. Increased OR time
e. Lack of training and experience (learning curve)
f. Requires general anesthesia
g. Requires use of mesh
h. Inadequate support from administration
i. Patient preference
j. Benefits of laparoscopy are minimal
k. other

3. Should LIHR be limited to surgeons with specialized training in minimally invasive techniques?

a. Yes
b. No
c. Unsure

4. Should all residents graduating from general surgery programs be competent to perform LIHR?

a. Yes
b. No
c. Unsure

5. Are the graduating residents competent to perform LIHR?

a. Yes
b. No
c. Unsure

6. In your opinion, about how many LIHRs should be performed to achieve competence?

a. At least 25
b. At least 50
c. At least 100
d. At least 200
e. greater than 200
f. Unsure

7. If you don't perform LIHR are you interested in learning?

a. Yes
b. No
c. Unsure

8. If you are interested in learning LIHR, what has been preventing you from doing so?

a. Not enough time,
b. Worried about safety during learning curve
c. Worried about lack of basic laparoscopic skills
d. Lack of equipment in your institution.

9. In general, what is the best educational method to learn a new procedure such as LIHR? (Choose all that apply)

a. Observe expert in the OR
b. Weekend courses with cadavers
c. Course followed by expert proctoring
d. Mini fellowship
e. Simulation
f. Attending meetings
g. Teleproctor
h. Other - specify

10. What is a feasible method in your practice? (Choose all that apply)

a. Observe expert in the OR
b. Weekend courses with cadavers
c. Course followed by expert proctoring
d. Mini fellowship
e. Simulation
f. Attending meetings
g. Teleproctor
h. Other - specify