Original Article

Decreasing use of open procedures in elective inguinal hernia surgery

Kristoffer Andresen^, Jacob Rosenberg

Center for Perioperative Optimization, Department of Surgery, Herlev Hospital, University of Copenhagen, Herlev, Denmark

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Correspondence to: Kristoffer Andresen. Center for Perioperative Optimization, Department of Surgery, Herlev Hospital, University of Copenhagen, Borgmester Ib Juuls Vej 1, 2730 Herlev, Denmark. Email: kristofferandresen@gmail.com.

Background: There is a change in the use of surgical methods for the repair of inguinal hernias. In Denmark, the national guidelines recommend either the Lichtenstein or the laparoscopic repair. The laparoscopic repair has gained popularity over the last years. The aim of the current study was to report trends in techniques for the repair of elective inguinal hernias, with focus on the Lichtenstein repair, the laparoscopic repair, and reoperation rates.

Methods: This cohort study was based on data from the Danish Inguinal Hernia Database from January 1, 1998, until December 31, 2019. The outcome in this study was trends in the use of surgical methods for the repair of groin hernias in Denmark. Results were divided on patients with unilateral and bilateral groin hernia repairs. Patients were also divided into six groups depending on which year they were operated. The first group consisted of patients operated from 1998 to 2002, the second group was operated from 2003 to 2006, the third group from 2007 to 2010, the fourth group from 2011 to 2014, and the last group was operated from 2015 to 2019.

Results: In total 173,302 patients initially operated electively for a groin hernia were included. There were several different methods being used for unilateral hernia repairs; however, there seems to be fewer methods in use compared with earlier. The laparoscopic repairs accounted for 96% of the bilateral inguinal hernias and 51% of the unilateral hernias. There has been a decrease in the use of the Lichtenstein method through the years. After 2017, the majority of patients received a laparoscopic repair for a primary unilateral inguinal hernia.

Conclusions: In conclusion, this study demonstrated that over the last 21 years there has been an increase in the use of laparoscopic repair for bilateral inguinal hernia that now covers almost 100%. For primary unilateral hernias, the laparoscopic approach is increasingly being used now covering more than half of the operations. Basic surgical training might need to include laparoscopic repair of inguinal hernias in the future.

Keywords: Inguinal hernia; laparoscopic surgery; Lichtenstein; femoral hernia; database study

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^ ORCID: 0000-0002-9820-3580.

Introduction

Treatment of inguinal hernias usually involves surgical repair, and throughout history of surgery numerous surgical methods have been presented (1,2). The large number of different methods could be an indication that no single method yet has been proved to be the best for all patients, surgeons, settings, and hernias. In Denmark, activity and outcomes after groin hernia repairs are monitored within the Danish Inguinal Hernia Database (3). One of the first large studies from the database was a presentation of the first 30 months after initiation of the database (4). The study demonstrated that several different open repair techniques and two types of laparoscopic repair were in use and with many operations for recurrences (4). This led to an intensive effort to increase quality and in this context to focus on the Lichtenstein technique to be the preferred operation for most patients. Some years later another study demonstrated an increase in the use of the Lichtenstein repair for inguinal hernia from approximately 35% in 1998 to 75% in 2006 (5). Concerning laparoscopic repair, from 1998 to 2006 there was almost no increase with laparoscopic repair being used for less than 10% of primary unilateral hernias (5). For bilateral inguinal hernias laparoscopic repair was in 2006 used for approximately 85% of all procedures in the country. The Danish Inguinal Hernia Database is the only truly national registry and with compulsory registration, where surgeons, both private and public, are obliged to register their procedures (6). It is possible with this database to perform nationwide quality monitoring. Thus, data from the Danish Inguinal Hernia Database have been used for quality improvement and development of guidelines (4,7,8). The Danish Hernia Database guideline recommends the Lichtenstein or the laparoscopic repair for men and the laparoscopic repair for women with primary groin hernias (7). There seems to be an increase in use of the laparoscopic approach to inguinal hernias, even for patients with primary unilateral hernias. If this trend continues, the volume of open inguinal hernia will decrease, which could have an impact on how training and teaching inguinal hernia should be organized in the future.

The aim of the current study is to report trends in techniques for the repair of elective inguinal hernias, with focus on the Lichtenstein repair, the laparoscopic repair, and reoperation rates.

We present the following article in accordance with the STROBE reporting checklist (available at http://dx.doi.org/10.21037/ls-20-126).

Methods

This cohort study was based on prospectively collected data from the Danish Inguinal Hernia Database (3). The database receives data from two sources: (I) the operating surgeon enters perioperative data about the patient and the hernia repair such as surgical method, type of anaesthesia, and classification of the hernia itself. (II) The other source of data is automatically extracted from the Danish National Patient Registry (9), where all hospitals, private and public, report procedural and diagnostic ICD10 codes.

This study included data from January 1, 1998, until December 31, 2019. The unit of analysis for this study was individual patients. Patient were included in the database and followed prospectively until end of study (December 31, 2019) or a re-operation for recurrence occurred, whichever came first. Patients that were bilaterally operated were followed until recurrence in either groin, or until end of the study. Patients were included if they had an uni- or bilateral elective groin hernia repair.

Patients were excluded from the study if they were less than 18 years of age, had missing information on operative details, or had their first repair registered before 1998. Index repair was a patient's first registered repair in the database, which could either be a bilateral or a unilateral groin hernia repair. We defined a bilateral groin hernia repair as a hernia repair in both the left and right groin on the same day.

The outcome in this study was trends in the use of surgical methods for the repair of groin hernias in Denmark. Furthermore, the reoperation rates were investigated. A reoperation was defined as a subsequent hernia repair in the same groin, irrespective of the finding; i.e., an inguinal hernia that recurred as a femoral hernia was considered a recurrence. For patients receiving at bilateral hernia, a recurrence was defined as a subsequent groin hernia repair in either the left or the right groin.

Results were divided on patients with unilateral and bilateral groin hernia repairs. Patients were also divided into six groups depending on which year they were operated. The first group consisted of patients operated from 1998 to 2002, the second group was operated from 2003 to 2006, the third group from 2007 to 2010, the fourth group from 2011 to 2014, and the last group was operated from 2015 to 2019.

For categorical variables, difference between groups were tested with the Chi-square test. For continuous variables the *t*-test was used if they were normally distributed; if not, the Mann-Whitney test was used. Re-operation rates were illustrated with Kaplan-Meier plots where differences

Table 1 Demographics, primary repair in the database, for the years 1998 to 2019

Demographic	Unilateral	Bilateral
N	161,344	11,958
Age (years), mean [SD]	57 [16]	59 [14]
Males, n [%]	146,327 [91]	11,063 [93]
General anaesthesia, n [%]	120,828 [91]	11,534 [97]
Type of hernia*, n [%]		
Inguinal	155,730 [97]	11,235 [94]
Femoral	3,899 [2]	380 [3]
Different hernias	–	551 [5]
Method, n [%]		
Lichtenstein	107,350 [67]	1,035 [9]
Laparoscopic	28,017 [17]	10,162 [85]
Other open mesh	11,483 [7]	311 [3]
Open non-mesh	7,023 [4]	105 [1]
Other procedure	4,484 [3]	43 [0]
Infra ligament	1,055 [1]	12 [0]
Onstep	965 [1]	5 [0]
Infra and supra ligament	696 [0]	8 [0]
Robot	260 [0]	90 [1]
Mixed (bilateral)**	–	187 [2]
Laparoscopic converted	7 [0]	0
Robot converted	4 [0]	0

*, <1% were registered with either "no hernia" or "combined inguinal/femoral" hernia; **, if patients were registered with two different types of surgery in the two groins, the technique is registered as mixed.

were investigated using the log-rank test. For statistical analysis and graphs the IBM SPSS Statistics version 25 were used. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). However, for this type of cohort study, no permission from institutional review boards is needed according to Danish law. The study was approved by the Danish Data Protection Agency (P-2020-631) and the Clinical Quality Development Program in the Regions of Denmark (RKKP).

Results

Initially, 226,415 records were in the database at time of data extraction. The repairs were sorted, and the dataset was restructured into individual patients. Since patients can receive hernia repairs in both groins and receive reoperations, there are more hernia repairs than patients in the database. In total 173,302 patients initially operated electively for a groin hernia were included, whereof 11,958 (6.9%) patients initially received a bilateral inguinal hernia repair [see *Table 1* for details of demographics for the entire period of the database (1998–2019)]. Overall, mean (SD) age were 57.6 (15.9). The patients operated for a bilateral groin hernia tended to include fewer females, but overall approximately 90% of the population were male patients. In *Table 1*, it is seen that most patients with unilateral hernias received a Lichtenstein repair, whereas the majority of patients with bilateral hernias received a laparoscopic repair.

Table 2 Demographics of patients receiving a primary repair in the years 2015 to 2019

Demographic	Unilateral	Bilateral
N	29,602	3,884
Age, mean [SD]	59 [16]	59 [14]
Male, n [%]	26,333 [89]	3,520 [91]
Left groin, n [%]	11,548 [39]	–
Type of surgery*, n [%]		
Laparoscopic	15,080 [51]	3,729 [96]
Lichtenstein	13,120 [44]	38 [1]
Robot	260 [1]	90 [2]

*, Procedures <2% has been omitted from the table.

In *Table 2*, the results of the last years (2015–2019) are seen. There were several different methods being used for unilateral hernia repairs; however, there seems to be fewer methods in use compared with earlier. Furthermore, the laparoscopic repairs accounted for 96% of the bilateral inguinal hernias and 51% of the unilateral hernias. The trends in repairs for the unilateral inguinal hernias can be seen in *Figure 1*. There has been a decrease in the use of the Lichtenstein method and an increase in the use of the laparoscopic method through the years. It is seen from the figure that after 2017, the majority of patients received a laparoscopic repair for a primary unilateral inguinal hernia.

For the patients with unilateral femoral hernias the trend is seen in *Figure 2*. In the first years of the database, several different methods were in use, however, there has been an increase in the use of the laparoscopic method and a decrease in all other methods during the last decade.

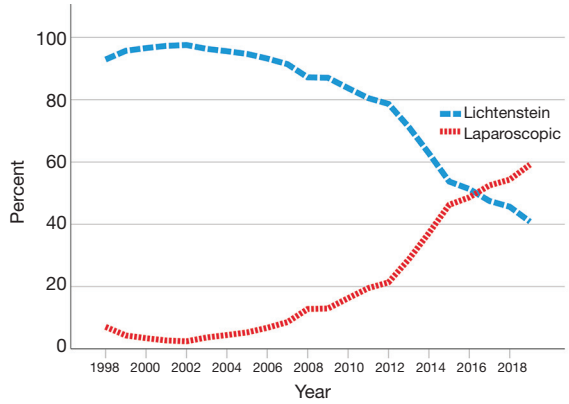

Figure 1 Patients' first registration in the database, operated for a unilateral, inguinal hernia.

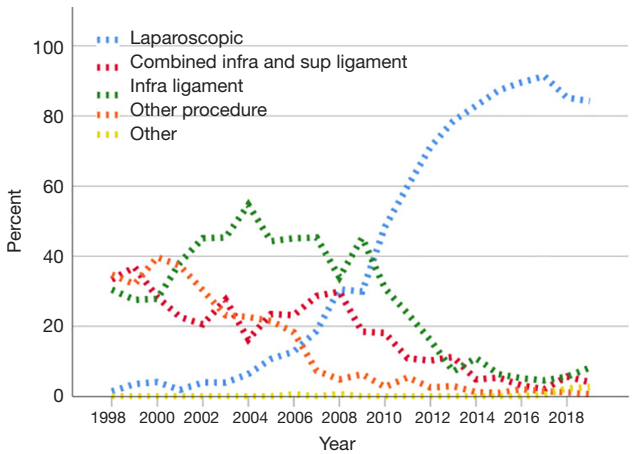

Figure 2 Patients' first registration in the database, operated for a unilateral, femoral hernia. Other contains different methods <5%.

For patients with bilateral inguinal hernias, the use of other methods has decreased, and the laparoscopic method now covers almost 100%.

For the unilateral laparoscopic repairs, the trends in re-operation rate over time is illustrated in *Figure 3*. It can be seen from the figure that the lowest reoperation rate is found among the patients operated in the most recent periods of the database, whereas the earliest group (1998–2002) had the highest reoperation rate, reaching a cumulated reoperation rate of 4–5% after 4 years. However, this development was not statistically significant. The reoperation rate for the bilateral hernias has also been stable over time (data not shown).

For patients operated with the Lichtenstein technique,

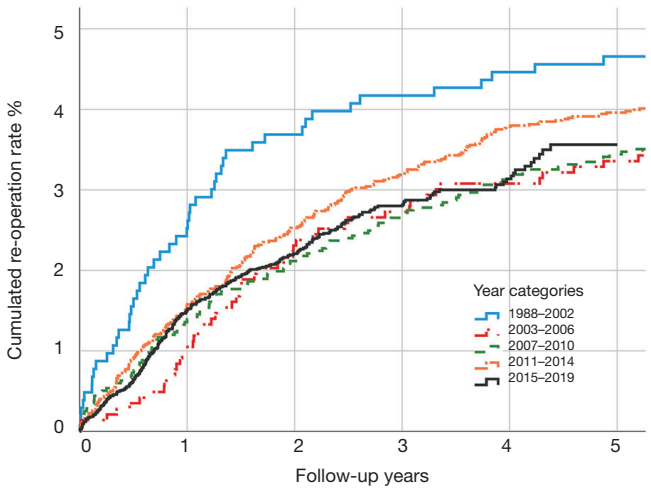

Figure 3 Kaplan-Meier plot of patients following laparoscopic repair of a first procedure in the groin. Stratified on years: 1998–2002, 2003–2006, 2007–2010, 2011–2014, 2015–2019. No statistical difference between groups. Note that follow up has been limited to 5 years in the plot.

an increase in the re-operation rate throughout the years from 1998 to 2014 was found, the last period (2015–2019) seems to be stabilizing and not increasing, overall log-rank, P<0.005 (*Figure 4*).

Discussion

This study has demonstrated the 21-year trend of surgical methods in Denmark for patients operated for groin hernias. We found that for unilateral inguinal hernia repairs, there has been an increased use of the laparoscopic repair, which in recent years covers more than half of the procedures. The patients operated with the laparoscopic approach have had stable reoperation rates throughout the years in contrast to the patients operated with the Lichtenstein repair, where an increase in the reoperation rates was found from 1998 to 2014. For the bilaterally operated patients, there has been an increase in the use of laparoscopic methods, now covering almost all operations, as in accordance with current guidelines. For the femoral hernias, the use of the laparoscopic method has also increased.

The increase in use of laparoscopic methods for the repair of primary unilateral groin hernias can have several explanations. It could be that patients increasingly wish for and ask for laparoscopic repair because of cosmetics and/or

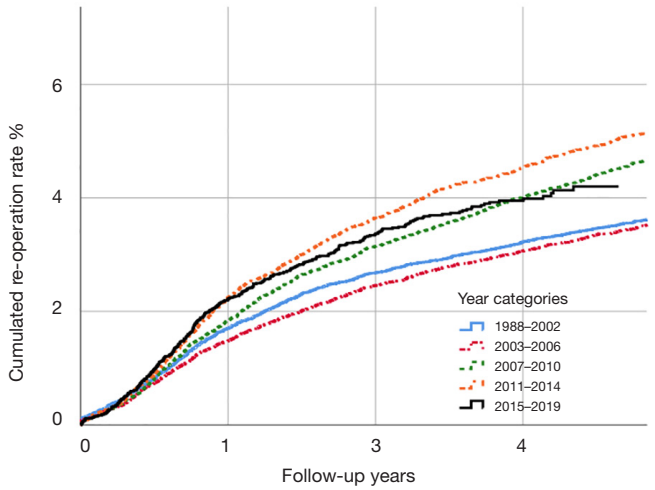

Figure 4 Kaplan-Meier plot of patients following Lichtenstein repair of a first procedure in the groin. Stratified on years: 1998–2002, 2003–2006, 2007–2010, 2011–2014, 2015–2019. A statistical difference between groups of years was found, log-rank P<0.005. Note that follow up has been limited to 5 years in the plot.

pain. For more than 80% of patients, there is no in chronic pain, no matter if the Lichtenstein or laparoscopic methods have been used, however, laparoscopy results in a lower risk of chronic pain according to international guideline (2). However, the positive effects of minimal invasive surgery compared with open repair has been documented in many studies (2,10) and is well known also in the general population. Another important factor for the change over time is probably also guidelines. In Denmark, the Danish Hernia Database arranges annual meetings for all surgeons interested in hernia repair, and from all departments in Denmark. At these meetings, current evidence for the treatment of hernias are discussed and consensus about strategies are sought. The Danish Hernia Database has formulated recommendations for the treatment of hernias (7). In these recommendations it is stated that men with unilateral primary groin hernias should be treated either with the laparoscopic approach or with the Lichtenstein repair. The choice of repair should be "depending on local expertise, economic considerations and patients' preferences". Since it is recommended to offer laparoscopic repair for women with inguinal hernia (7), some of the increased use of laparoscopy for femoral hernias could be explained. Some of the decrease in Lichtenstein could be explained by increased focus on the risk of disabling chronic pain following the Lichtenstein repair (11,12). It could also be that the expertise has become available to more departments and therefore it is possible that more departments offer laparoscopic repair to more patients.

Fortunately, the increasing use of the laparoscopic repair has not been followed by an increase in re-operation rates. The high volume of the laparoscopic repair is beneficial because the learning curve is long, with some studies indicating that the learning curve still exists after more than 200 repairs (2). Thereby the increasing number of laparoscopic repairs might be the factor that explains the stable recurrence rate. When an operative technique is being used more widely, there is a risk that not all surgeons performing the technique are able to provide sufficient quality, however, this does not seem to be the case here. On the other hand, one could have expected a decrease in the re-operation rate since the volume, and thereby experience with the laparoscopic technique, has increased. The Lichtenstein repair has had increasing re-operation rate, but seems to be stabilized now. However, the re-operation rate needs to be monitored closely in the future since fewer repairs could mean a loss of expertise and experience with this procedure. Data from the Swedish hernia database demonstrated an overall cumulative incidence rate of re-operation for recurrence at 2.2% for open mesh based repair (13). This seems lower than for the Danish Hernia database, where the most recent period demonstrated a cumulative re-operation rate of around 4%. This could indicate that there is room for improvement in Denmark, but in order to compare Danish and Swedish results, a collaborative study would be needed.

A strength of this study is the nationwide coverage with prospectively collected data with a high validity. A limitation is that the reoperation rates only is a proxy for recurrences since not all patients with a recurrence receives a reoperation. Thus, it has been demonstrated that the reoperation rates underestimate the true recurrence rate by approximately 40% (14). However, there is no indication that the true recurrence rate should have changed over time. If patients and surgeons now have become more reluctant to repair a recurrent hernia, then this could have in influence on the observed re-operation rates. However, we do believe that if there has been a change in the willingness to operate for recurrence, the change would have been away from a conservative approach to offering elective repair, since the laparoscopic repair (which is recommended following a Lichtenstein repair) is now more widely available. Another limitation is that there are different lengths of follow up, for the different groups. However, this was limited by using

the Kaplan-Meier plot and by only plotting data for 5 years. Also, surgeon experience was not considered in this study, since unique identification of surgeons was not available in the beginning of the database.

Traditionally, the Lichtenstein repair has been used for teaching hernia surgery to residents, whereas the laparoscopic inguinal hernia repair has not been part of the initial surgical training in our country. If the current trend continues, there will be very few Lichtenstein repairs left for surgical training in the future. In the future, maybe the Lichtenstein repair will be a procedure reserved for "special" cases and only to be done by dedicated hernia surgeons, whereas the laparoscopic repair should be implemented in surgical training. If the increase in laparoscopy continues, laparoscopy might be the default choice for patients in Denmark with an inguinal hernia in the future.

In conclusion, this study has demonstrated that over the last 21 years there has been an increase in the use of laparoscopic repair for bilateral inguinal hernia that now covers almost 100%. For primary unilateral hernias, the laparoscopic approach is increasingly being used now covering more than half of the operations, fortunately without an increase in the re-operation rates. Basic surgical training might need to include laparoscopic repair of inguinal hernias in the future.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). However, this study did not require ethical committee approval or patient consent according to Danish law. The study was approved by the Danish Data Protection Agency (P-2020-631) and the Clinical Quality Development Program in the Regions of Denmark (RKKP).

References

1. Andresen K, Rosenberg J. Open preperitoneal groin hernia repair with mesh: a qualitative systematic review. Am J Surg 2017;213:1153-9.
2. HerniaSurge Group. International guidelines for groin hernia management. Hernia 2018;22:1-165.
3. Friis-Andersen H, Bisgaard T. The Danish Inguinal Hernia database. Clin Epidemiol 2016;8:521-4.
4. Bay-Nielsen M, Kehlet H, Strand L, et al. Quality assessment of 26,304 herniorrhaphies in Denmark: a prospective nationwide study. Lancet 2001;358:1124-8.
5. Rosenberg J, Bay-Nielsen M. Current status of laparoscopic inguinal hernia repair in Denmark. Hernia 2008;12:583-7.
6. Kyle-Leinhase I, Köckerling F, Jørgensen LN, et al. Comparison of hernia registries: the CORE project. Hernia 2018;22:561-75.
7. Rosenberg J, Bisgaard T, Kehlet H, et al. Danish Hernia Database recommendations for the management of inguinal and femoral hernia in adults. Dan Med Bull 2011;58:C4243.

8. Kehlet H, Bay-Nielsen M; Danish Hernia Database Collaboration. Nationwide quality improvement of groin hernia repair from the Danish Hernia Database of 87,840 patients from 1998 to 2005. Hernia 2008;12:1-7.
9. Lynge E, Sandegaard JL, Rebolj M. The Danish National Patient Register. Scand J Public Health 2011;39:30-3.
10. Bullen NL, Massey LH, Antoniou SA, et al. Open versus laparoscopic mesh repair of primary unilateral uncomplicated inguinal hernia: a systematic review with meta-analysis and trial sequential analysis. Hernia 2019;23:461-72.
11. Aasvang EK, Bay-Nielsen M, Kehlet H. Pain and functional impairment 6 years after inguinal herniorrhaphy. Hernia 2006;10:316-21.
12. Andresen K, Rosenberg J. Management of chronic pain after hernia repair. J Pain Res 2018;11:675-81.
13. Melkemichel M, Bringman SAW, Widhe BOO. Long-term comparison of recurrence rates between different lightweight and heavyweight meshes in open anterior mesh inguinal hernia repair: a nationwide population-based register study. Ann Surg 2021;273:365-72.
14. Kald A, Nilsson E, Anderberg B, et al. Reoperation as surrogate endpoint in hernia surgery. A three year follow-up of 1565 herniorrhaphies. Eur J Surg 1998;164:45-50.

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