Femoral and Inguinal Hernia

How to Minimize Adverse Outcomes Following Repair

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Abstract

Groin hernia is common, and each year 200 repairs per 100 000 adult inhabitants are performed in Sweden. Groin hernias are either inguinal or femoral (2-4%). Elective repair is not associated with an excess mortality, but adverse outcomes include recurrence and long-term pain. Emergency procedures have a 4% mortality rate with an increased risk for bowel resection and postoperative complications. The aim of this thesis was to identify risk factors for adverse outcomes and to propose measures to improve groin hernia treatment.

Twenty-three per cent of female hernias were femoral. Thirty-six per cent of femoral hernias, and 5% of inguinal hernias, have emergency procedures. Females (OR 1.47) and patients above 65 years-of-age (OR 2.24) were at higher risk for emergency repair. Bowel resection was performed in 23% of emergency femoral repairs, and the 30-day mortality was 10 times that of an age- and gender-matched population. The majority of emergency patients were unaware of their hernia, and one third had previously had no groin symptoms.

Femoral repairs were at larger risk for recurrence than inguinal repairs. The surgical techniques with least risk for recurrence were preperitoneal mesh repairs (open HR 0.28, and laparoscopic HR 0.31). Long-term pain was present in 24% of femoral hernia patients, of whom 5.5% described pain interfering with daily activities. The only factor predicting the risk for long-term pain was pain preoperatively. Pain decreased with time.

In a randomized study on inguinal hernia, TEP resulted in less pain six weeks after surgery than Lichtenstein repair performed under local anesthesia (LLA). TEP patients were to a larger extent able to perform sporting activities. No difference was seen in intra-operative complications.

Femoral hernias should be given high priority for repair and preperitoneal techniques should be used. Earlier diagnosis, in the elective setting, is probably difficult to attain. Heightened awareness in the emergency department is required. TEP is safe, and results in less pain than LLA six weeks after surgery. A widening of indications for TEP in primary inguinal hernia repair is justifiable.

Keywords: femoral hernia, inguinal hernia, adverse outcome, complication, recurrence, chronic pain, long-term pain, emergency, mortality, TEP, Lichtenstein, local anesthesia

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Anybody who has been seriously engaged in scientific work of any kind realizes that over the entrance to the gates of the temple of science are written the words: 'Ye must have faith.'

Max Planck
This thesis is based on the following papers, which are referred to in the text by their Roman numerals:


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Abbreviations

ASA American Society of Anesthesiologists
BMI Body Mass Index
CI Confidence Interval
EHS European Hernia Society
GA General Anesthesia
HR Hazard Ratio
IPQ Inguinal Pain Questionnaire
IQR Inter-Quartile range
LA Local Anesthesia
LLA Lichtenstein under Local Anesthesia
NSAID Non Steroidal Anti-Inflammatory Drug
OR Odds Ratio
PIN Personal Identity Number
SBR Svenska Bräckregistret
SHR Swedish Hernia Register
SKL Sveriges Kommuner och Landsting
SMR Standardized Mortality Rate
TEP Totally Extraperitoneal Repair
Introduction

Epidemiology
Groin hernias are common and repair is the most frequent procedure in gastrointestinal surgery with an annual operation rate of 200/100 000 adult inhabitants\(^1\). More than 90% of groin hernia repairs are performed in males\(^1\).\(^2\). The lifetime risk for hernia is 24% and among men \(\geq\)75 years, 47% have had surgery for a groin hernia or have one currently\(^3\).

Groin hernias can be divided into two groups: inguinal and femoral. The absolute majority of groin hernias are inguinal, with only 2-4 % femoral\(^4\)-\(^6\).

Anatomy and classification
Femoral hernia
Medial to the femoral vein and postero-inferiorly to the inguinal ligament is a short conical space, the femoral canal. The femoral sheath, which encloses the femoral artery and vein, also surrounds the femoral canal. The canal harbors loose connective tissue, fat and lymph vessels. It is wide at the proximal end, called the femoral ring. This opening, which is covered by preperitoneal fat, is situated medial to the femoral vein, lateral to the lacunar ligament, anterior to the posterior ramus of the pubis and pectineus muscle, and posterior to the medial part of the inguinal ligament\(^7\). Herniation through the femoral ring, into the femoral canal, is called a femoral hernia.

A femoral hernia is usually palpable medially in the groin, caudal to the inguinal ligament, but can also be deflected with a swelling palpable cranial to the ligament making it difficult to distinguish from an inguinal hernia\(^8\). Femoral hernias are more common in females who have wider pelvises. It is mainly an affliction of the elderly, possibly attributable to muscular atrophy or a change in composition of collagen. Multiparity is considered another risk factor\(^9\)-\(^11\). The rigid boundaries of the femoral ring is thought responsible for a high incarceration risk with femoral hernias.
Inguinal hernia

Inguinal hernia is, by far, the most common of the groin hernias. These hernias are situated above the inguinal ligament. The inguinal canal runs parallel to, and on the superior surface of the inguinal ligament, its deep orifice at the cranial end, an opening in the transversalis fascia. The superficial aperture is formed by a division in the aponeurosis of the external oblique muscle before its insertion onto the pubic bone. The canal is approximately 4 cm long and connects the abdominal cavity and the scrotum/major labia, traversing the abdominal wall. It runs obliquely, in an infero-medial direction and consequently the deep and superficial openings do not coincide, which accounts for the shutter mechanism. The posterior wall of the canal consists of the transversalis fascia and the common tendon of the internal oblique and the transversus abdominus muscle; the conjoint tendon. The aponeurosis of the external oblique muscle forms the anterior wall. The inguinal and lacunar ligaments form the floor of the canal, and the roof consists of fibers from the internal oblique and tranverse muscles arching over the canal.  

The main content of the canal is the spermatic cord in males and the round ligament in females. Medial to the deep orifice is the inferior epigastric artery. This is the landmark for medial versus lateral inguinal hernias. The lateral (indirect) hernia enters the inguinal canal through the deep opening and is surrounded by all the layers of the spermatic cord (or female equivalent). The weakness resulting from the testis or the round ligament descending through the inguinal canal, is more marked in males and lateral hernias are hence more common in men. The medial (direct) hernia protrudes directly through the abdominal wall, medial to the inferior epigastric artery. Both lateral and medial hernia, however, often protrude through the superficial ring, and it is difficult to tell medial and lateral hernias apart by clinical examination. The posterior abdominal wall is strong in women and medial hernias are thus uncommon.

Nerves

The nerve supply to the inferior part of the abdominal wall and the groin is mediated by the peripheral ilio-hypogastric, ilio-inguinal, and genito-femoral nerves.

The ilio-hypogastric nerve

This nerve arises from the first lumbar segment. It runs in front of the quadratus lumbar muscle, retroperitoneally, and penetrates the transversalis muscle in the anterior abdominal wall cranial to the anterior superior iliac spine. The nerve runs infero-medially on the internal oblique muscle till it pierces the externus aponeurosis cranial to the superficial inguinal ring. The nerve sup-
plies the muscles of the anterior abdominal wall and the skin covering the hip and the pubic area.

The ilio-inguinal nerve
This nerve also stems from L1 and runs slightly caudally to the ilio-hypogastric nerve. It pierces the transversalis, and then the internal oblique muscle medial to the anterior superior iliac spine. It usually runs along the spermatic cord and passes through the superficial inguinal ring. In addition to the anterior abdominal wall muscles, it supplies the skin the skin of the inguinal region, the labia majora or the root of the penis and the scrotum.

The genito-femoral nerve
From its origin L1 and L2, it transverses the psoas muscle and runs inferiorly on the iliac fascia. Lateral to the common iliac artery it divides into a femoral and a genital branch. The femoral branch crosses, superficial to the external iliac artery and, distally to the inguinal ligament, pierces the femoral sheath to supply the skin over the femoral triangle. The genital branch enters the inguinal canal through the internal ring, often between the inner layers of the spermatic cord. This branch supplies the cremaster muscle.

Classification
Several classifications have been used. After inventory of the existing ones, the European Hernia Society (EHS) has proposed a new classification in an effort to unify surgeons and simplify comparison of results16(Table 1).

Table 1. The EHS groin hernia classification.

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<thead>
<tr>
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<th>P (primary)</th>
<th>R (recurrent)</th>
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<tbody>
<tr>
<td>L (lateral)</td>
<td>0 1 2</td>
<td>3 x</td>
</tr>
<tr>
<td>M (medial)</td>
<td>F (femoral)</td>
<td></td>
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</tbody>
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The classification is designed to be easy to remember and to define anatomic localization of hernia, size of hernia orifice and allow distinction between primary and recurrent hernia. Size is approximated by how many index fingers wide the orifice is. The appropriate box in the classification table (Table 1) is ticked, and P or R encircled to indicate whether it is a recurrent hernia or not. In the case of combined hernia, multiple boxes are ticked. The issue of a diffuse bulge of the posterior wall, not possible to invaginate by plication of the transversalis fascia and hence not considered a proper medial hernia, is indicated by adding an “x” to the classification.
Treatment

Hernias can only be cured by surgery, but that does not necessarily mean that all hernias should be operated upon. There are two reasons for elective repair of groin hernia; to alleviate symptoms and to avoid future complications of the hernia.

For patients with symptoms that affect daily activities, surgical repair is reasonable and recommended. Patients who do not have symptoms, or whose symptoms are minimal, should be advised to have an elective repair if the risk for complications of the hernia is estimated to outweigh the risk for complications from elective surgery. The true risk for incarceration is not known, but studies have estimated the overall risk for groin hernias to be 0.3-3% annually. The risk is considered greatest for hernias with a short history. An over-risk is seen for femoral hernias in which Gallegos has shown a risk for incarceration of 22% in the first month after diagnosis and 45% within 21 months.

Two randomized trials have indicated that watchful waiting is a sufficiently safe approach in males with a minimally symptomatic inguinal hernia. The European Hernia Society, in their guidelines, and the Swedish national indications for groin hernia surgery state that watchful waiting should be considered in minimally symptomatic men. Sarosi suggests a selection of patients, putting forward prostatism, constipation, marital status and pain at work as risk factors for crossing over to surgical treatment. Recent results from 7.5 year follow-up in one of the randomized trials suggest that most patients develop symptoms, mainly pain, requiring elective repair at a later stage. Almost 60% of the men randomized to observation subsequently crossed over to surgery. There is concern that the delay in surgery in these cases may not have been beneficial, but rather has increased the risk of co-morbidity and technically demanding hernia as well as the risk of incarceration.

For femoral hernia, with an inherently high risk for incarceration, and in females, with a high proportion of femoral hernias, prompt repair is strongly recommended, even in the absence of symptoms.

Surgery

Groin hernia repair aims to restore a strong abdominal wall. There are two principal ways to achieve this; closing the defect using the patients own tissue, or reinforcement of the abdominal wall with foreign material for added strength.

Sutured repairs

The inguinal canal, in particular the posterior wall, is reconstructed by suturing together the defect. This can be accomplished in several ways and sever-
al techniques for herniorraphy have been described. The Bassini repair involves division of the transversalis fascia, ligation of the hernial sac, and reconstruction of the posterior wall by suturing the transversalis fascia to the inguinal ligament using interrupted non-absorbable sutures. Marcy described a repair where the inner ring is tightened by sutures after ligation of the sac. The Shouldice repair is considered the best of the sutured repairs. It stresses the importance of a thorough dissection and making sure that a second herniation is not overlooked. The transversalis fascia is divided, creating tissue flaps which are sutured to each other in an overlapping manner.

Anterior mesh repairs
Mesh repairs were introduced in order to allow repairs that do not inherently lead to tension in the tissues. Fixation of a flat nylon mesh with a slit for the cord to the anterior abdominal wall, underneath the aponeurosis of the external oblique muscle, was described as early as the 1950's. Lichtenstein reported a similar procedure, with a polypropylene mesh, in the 1980's. Their concept includes use of local anesthesia (LA) and ambulatory surgery. After dissection of the inguinal canal and removal of the hernia sac, a mesh is placed on the abdominal wall and fixated with non-absorbable sutures. The Lichtenstein procedure is easy to learn and seems forgiving. Due to repeatedly good results using this repair, the Lichtenstein procedure is now considered the Gold Standard of hernia repair. Important details during repair are to use a mesh with sufficient size and to fixate it so that it overlaps the pubic tubercle by 2cm.

Plug repairs
The object is to obliterate the abdominal wall defect by introduction of foreign material. Conceptually it emmanates from the “external invagination” method (using a wooden plug or skin inverted by sutures to push the hernia back) used prior to introduction of incisional repairs. A conical prosthesis is inserted, tip first, into the defect and fixated. For inguinal hernias an onlay patch is placed, without fixation, on the anterior surface of the posterior wall. When the technique is used in an infra inguinal approach for femoral hernias, no flat mesh is applied and the plug can be inserted from either side of the ligament.

Open preperitoneal mesh repairs
A preperitoneal placement of the mesh is, theoretically, preferable in physiological terms, since increased abdominal pressure presses a mesh in that position onto the defect rather than away from the defect, as would be the case with a mesh placed on the outside of the muscle. In open preperitoneal repair a skin incision is made, either in the midline or via a transverse supra-inguinal line. Dissection of the preperitoneal space gives a view of the posterior face of the abdominal wall, depicting all hernia orifices. The dis-
section is performed in an area where the surgeon does not come into con-
flict with the neural supply of the groin. In a unilateral approach the defect is first closed, then a flat mesh is positioned and fixated to Cooper's liga-
ment, using non-absorbable sutures. Initially a mesh size of 10x4 cm was considered appropriate, but with realization of the importance of mesh over-
lap, size used has increased to about 12x15 cm.

**Laparoscopic preperitoneal mesh repairs**

Access to the preperitoneal space is either via the transabdominal route or from the retromuscular position without incising the peritoneum. A preperi-
toneal dissection is performed using laparoscopic equipment. A mesh is in-
troduced and placed so that all three hernial orifices are covered and overlapped. Laparoscopic hernioplasty is always performed under general anes-
thesia (GA). The concept is to combine the advantages of open preperitoneal mesh techniques with a minimally invasive access technique.

**Results**

Recurrence after repair used to be a major concern in quality measurement, with recurrence rates well over 10%. The rate of recurrence has decreased though. This can be attributed to a few parallel processes: the introduction of the tension-free repair using a mesh for reinforcement; centralization, in some countries, of the hernia surgery to specialist centers; the use of regional or national registers; and implementation of guidelines. All of these measures have contributed to recurrence rates decreasing to a level of two per cent at two years after surgery.

With reduced recurrence rates other measurements of quality has come into focus. The outcome most investigated is chronic pain after inguinal her-
nia repair. Instruments for assessment of pain have been designed and pain after surgery has been shown a rather frequent phenomenon. Approximately 30% of patients report that they have pain in the operated groin a few years after surgery. Between 5 and 10% report pain of a moderate or severe de-
gree, interfering with activities. Pain has been shown to diminish with time, even if it is present for several years. Risk factors for pain are young age and the occurrence of postoperative complications. For inguinal hernia repairs, an association has been seen between surgical technique and chronic pain, with a higher risk for pain after an anterior repair. On the other hand patients have less pain, at least during the first postoperative week, after repairs performed under local anesthesia than under general or regional anesthesia. Local anesthesia also has the advantage of being a low cost anesthetic procedure with fewer complications, such as urinary retention or post-anesthetic nausea.
Hernia is a benign condition and repair is considered routine surgery. There is no excess mortality for elective procedures. However, the mortality for emergency repair is approximately 4%.
Aims of the thesis

The general aim of this thesis was to identify risk factors for adverse outcomes after groin hernia repair and to propose measures to improve groin hernia treatment.

The study specific aims were:

Paper I: to describe the characteristics of femoral hernias and outcome of femoral repairs, with special emphasis on emergency surgery.

Paper II: to describe the prevalence of chronic pain after repair for femoral hernia and to identify risk factors associated with chronic pain after femoral hernia repair.

Paper III: to compare symptoms prior to femoral hernia repair between patients treated electively and as an emergency, and to define possible strategies to reduce the frequency of emergency procedures due to incarceration of femoral hernia.

Paper IV: to compare results after TEP under general anesthesia with those after Lichtenstein under local anesthesia in terms of pain six weeks after surgery, and to compare intra-operative complications in the two groups.
Patients and methods

Swedish Hernia Register

The Swedish Hernia Register (SHR) comprises groin hernia repairs in patients above 15 years-of-age, registered prospectively. It was established in 1992 and included eight hospitals from the start. The register quickly grew and since 2004 has had coverage exceeding 95% of groin hernia repairs performed in Sweden.

Patient characteristics such as age, gender and body mass index (BMI) are registered. The hernia repaired is defined in terms of side, anatomy and size of the defect. Note is also taken of indication for surgery: primary hernia; recurrent hernia; reoperation due to pain or deep infection. Reoperation due to recurrence is defined as hernia repair after previous hernia surgery (at age 15 or older) in the same groin. Mode of admission (elective/emergency), administration of antibiotics, incision, type of repair, materials used, operating time, and intra-operative complications are details of the repair that are recorded. Classification as emergency repair requires admission due to symptoms of incarceration and surgery within 24 hours. All patients are registered with their personal identity number (PIN)\textsuperscript{53} which allows linking with former and future repairs registered in the SHR.

Paper I

Study population

Data on all femoral and inguinal hernia repairs registered in the SHR during 1992-2006 were accessed. In these 15 years, prospective data on 138 309 inguinal and 3 980 femoral hernia repairs had been gathered.

Statistical methods

Distribution of patient characteristics and type of hernia were calculated using descriptive statistics. Actuarial analysis was used to calculate cumulative rate of reoperations due to recurrence, and log-rank test was used for comparison between groups. For femoral repairs additional analyses were made. Factors associated to relative risk for reoperation due to recurrence were in-
vestigated using Cox proportional hazard regression model. Logistic regression was used for analyzing factors associated with 30-day postoperative mortality. The predictive factors analyzed for both these outcomes were: gender; age; side of the hernia; bilateral hernia; recurrent hernia; type of repair, intra-operative complication; bowel resection; and postoperative complication. Age was categorized as below or above median age. Operating techniques were grouped into five categories: sutured; open anterior mesh; plug; open preperitoneal mesh; and laparoscopic (preperitoneal). In both the Cox proportional hazards model and the logistic regression model, univariate analyses were carried out first and the predictors with an association were included in the multivariate analysis. Standardized Mortality Rate (SMR), for the first 30 postoperative days, was calculated for femoral repairs performed 1992-2004. SMR is a mortality measure comparing observed deaths to expected in an age- and gender-matched population. Vital statistics were acquired from www.scb.se for calculations, 95% confidence intervals (CI) were constructed assuming a Poisson distribution of events.

Paper II

Study population
Data on femoral hernia repairs performed January 1st 1997 through December 31st 2006 were extracted from the SHR. In total 3541 repairs involving femoral hernias had been performed during that time. Patients with multiple procedures, regardless of whether in the same groin, were excluded. The PIN of the remaining 2542 patients were matched to the Swedish Population Register. After identification of patients who were deceased and those with no known address, 1967 eligible patients remained to whom a questionnaire was sent.

Questionnaire
The Inguinal Pain Questionnaire (IPQ, Appendix A) is a validated instrument for assessment of groin pain. Pain intensity and effect on daily activities are addressed. Intensity is graded on an ordinal seven degree scale, each degree with a verbal description, ranging from “no pain at all” to “pain so severe that it necessitates seeking emergency care”. The intensity of pain at three points in time is asked about: pain prior to surgery; pain at the precise moment of completing IPQ; and maximum intensity during the week preceding completion of IPQ. Effect of groin pain on specific daily activities is defined as: difficulty in getting up from a low chair; sitting for more than 30 minutes; standing for more than 30 minute; ascending or descending stairs; driving a car; or performing sporting activities. Consumption of analgesics,
and if so what substance, and need for sick-leave due to pain in the operated
groin are inquired about. A scoring system, IPQ-score, summing up the
severity of pain in one single measure was defined. Each step above “no pain
at all” on the intensity scale regarding pain during the past week, and each
activity (of the six specified) that was hampered by pain in the groin,
rendered one point, giving an IPQ-score ranging from zero to twelve.
Questionnaires were sent out in late May 2008, resulting in a minimum
follow-up time of 18 months.

Statistical methods
Comparisons between responders and non-responders were conducted using
the Chi-square test. Association of possible risk factors to chronic postoper-
ative pain was investigated by separate logistic regression models for “pain
right now”, “most severe pain past week” and IPQ-score. Factors evaluated
were age (above or below median), gender, size of the defect, concurrent in-
guinal hernia, type of repair, intra- and postoperative complications, time
since surgery and estimated preoperative pain. Those variables that were as-
sociated with chronic pain in univariate analysis, were included in a mul-
tivariate model. In these analyses type of repair was divided into five groups:
sutured repair; anterior mesh; plug; open preperitoneal mesh; and laparo-
scopic mesh. A subgroup among the sutured repairs had been entered into the
SHR as “hospital-specific/unspecified” suture repair. A separate analysis was
run to investigate the association between such a repair and emergency sur-
gery.

Paper III
Study population and questionnaire
The same study population as in paper II was used. Six hundred and twenty-
seven patients had had an emergency repair, whereas 1 340 had been treated
electively. All eligible patients were sent a questionnaire (Appendix B) re-
garding symptoms and health care contacts prior to their hernia repair. They
were asked whether they had been aware of their hernia and, if so, for how
long. Another set of questions addressed symptoms from the groin or other
symptoms they attributed to the hernia, that had been present at least two
weeks prior to surgery. Thirdly, the patients were asked if they had consulted
a primary care physician or a surgeon about their hernia, and if they had
been put on the waiting list for surgery prior to admission. Answers were
matched to data registered in the SHR.
Statistical analysis

Chi-square test was used to compare responders to non-responders. Answers from patients treated as emergencies were compared to those from electively treated patients using descriptive statistics and Chi-square (or if appropriate Fisher's exact) test. Logistic regression models were constructed to investigate the association between patient- and hernia characteristics and answers to the questions. Outcomes analyzed were: awareness of hernia; groin symptoms; any symptoms (either in the groin or other); general practitioner consulted; surgeon consulted; on waiting list. Predictive variables investigated, aside from emergency operation or not, were: gender; age (categorized as above or below median age); BMI; right- vs left- sided hernia; and combined vs solitary femoral hernia. Univariate analysis was performed for all variables for each outcome. Variables with a significant (0.05 significance level) association and those of specific interest, such as gender, were included in a multivariate analysis. Data on BMI was only available for one third of patients and BMI was hence not included in the multivariate analysis.

Paper IV

Study population

Recruitment was performed in the outpatient clinic of either of the two hospitals in Uppsala County, Sweden. Patients with an inguinal hernia necessitating repair were considered. The inclusion criteria were: male; unilateral primary hernia; age between 20 and 80 years; ASA score I-III; and understanding of the Swedish language. Patients had to be suitable for GA, LA and laparoscopic as well as open repair. Preperitoneally placed mesh is the recommended technique for hernia in females and recurrent hernia and these patients were hence excluded. The laparoscopic approach is beneficial for patients with bilateral hernia, and this was the rationale for exclusion of those patients.

Randomization was performed immediately prior to surgery. Sealed, opaque, consecutively numbered envelopes in blocks of 20 were used. Eligible patients were randomized, in a 1:1 ratio, between open Lichtenstein repair under local anesthesia (LLA) and laparoscopic totally extra-peritoneal (TEP) repair. In total, 389 patients were randomized and allocated to open (195) or laparoscopic (194) procedure. Five of them were, however, treated in violation of protocol and therefore excluded from the study. One hundred and ninety-one patients entered the LLA group, and 193 entered the TEP group.
Procedures

The same kind of mesh, full-weight polypropylene, was used in both groups. Both procedures were standardized and to be performed in a cost-optimized manner. Need for extra equipment was registered. All procedures were registered in the SHR and in a study-specific database containing information on the procedure, intra-operative complications and complexity level.

Open surgery was performed ad modum Lichtenstein\textsuperscript{55}. Local anesthesia was administered by infiltration technique\textsuperscript{56}, using a mixture of equal volumes of bupivacaine 5mg/ml and mepivacaine 10mg/ml. Sedation was allowed if needed. Conversion to general anesthesia was recorded. The mesh was fixed by non-absorbable monofilament suture.

TEP was carried out with reusable equipment and without a dissection balloon. Participating surgeons were recommended not to fix the mesh, but fixation with fibrin glue or staples was allowed. The procedure was performed under GA. Conversion to open surgery was noted.

Follow-up

Six weeks after the operation the patients received the IPQ via mail. A reminder, if necessary, was sent and if lack of response persisted, the patient was reminded by phone.

Statistical analysis

Design of the study was made with pain one year after surgery as the primary outcome measure. Intended sample size was arrived at assuming a prevalence of pain around 20\% for the TEP group and 35\% for the LLA group. This assumption was made based on previous results from our research group\textsuperscript{42}.

Non-parametric tests were used: Mann-Whitney U test for continuous and ordinal outcomes; and Chi-square test, or Fisher's exact test where appropriate, for nominal outcomes. All analyses were performed according to intention-to-treat.

Ethical considerations

All the papers included in this thesis are the results of projects approved by the Regional Ethics Committee in Uppsala, Sweden, prior to realization.

Paper I is purely based on data registered regarding previously performed surgical procedures. Paper II and III are retrospective studies where patients, who agreed to participation, answered questions about their previously treated femoral hernia. Paper IV results from a study where patients, upon
informed consent, were randomized to either of two repair methods already in routine use. In all of these studies, the risk for the participating research subjects was considered low. The potential benefits were primarily ascribed to the possibility of identifying more optimal treatment methods and care for patients with femoral or inguinal hernia.
Results

Paper I

Patients with femoral hernia had a median age of 65 years at surgery, compared to 60 years for inguinal hernia patients. Among femoral hernia patients, those who had emergency repairs were older (median 76 years vs 59 years for elective patients). Recurrences were more common after femoral hernia than after inguinal hernia. Five years after surgery 4.2% (95%CI 4.1-4.4) of patients with inguinal hernias and 6.6% (95%CI 5.6-7.7) of femoral hernia patients had been reoperated. The difference in cumulative rate of reoperation is seen in Figure 1. No difference was seen between electively repaired femoral hernias and those treated as emergencies.

Figure 1. Cumulative rate of reoperation due to recurrence in femoral and inguinal hernias, respectively. Based on the 142 289 hernia repairs registered in the SHR 1992-2006.
Results from the analysis regarding risk factors for reoperation due to recurrence for elective repairs are presented in Table 2. Repairs performed with laparoscopic or open pre-peritoneal technique had a decreased risk for recurrence (lap: hazard ratio [HR] 0.31, 95% CI 0.15-0.67, open: HR 0.28, 95% CI 0.12-0.65) compared to that of sutured repairs.

Comparison of 30-day mortality after femoral hernia repair to the expected mortality in an age- and gender-matched Swedish population showed an increased risk after emergency surgery. Table 3 accounts for the results regarding SMR.

In the elective group, postoperative mortality was rare enough (0.16%) not to permit analysis of risk factors. Patients who had emergency surgery were at greater risk for post-operative death if they were male (odds ratio [OR] 1.43, 95% CI 1.11-1.85), above median age (OR 3.47, 95% CI 1.71-7.04) or had an intra-operative complication (OR 2.41, 95% CI 1.45-4.01). Other factors indicating increased risk were: need for bowel resection during repair (OR 1.98, 95% CI 1.53-2.56); and post-operative complications (OR 2.07, 95% CI 1.60-2.69). Emergency repair was more common among females (OR 1.47, 95% CI 1.35-1.59) and patients older than 65 years (OR 2.24, 95% CI 2.07-2.43), whereas no difference was seen regarding side of the hernia.
Table 2. Hazard ratio (HR) for reoperation due to recurrence for 2,524 elective femoral repairs registered in the Swedish Hernia Register, 1992 to 2006.

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<th>Reoperated</th>
<th>Univariate model</th>
<th>Multivariate model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/No. at Risk (%)</td>
<td>HR (95%CI)</td>
<td>HR (95%CI)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤65yrs</td>
<td>81/1598 (5.1)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>&gt;65yrs</td>
<td>34/926 (3.7)</td>
<td>0.78 (0.52-1.17)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>51/1460 (3.5)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>64/1064 (6.0)</td>
<td>1.87 (1.30-2.71)</td>
<td>1.87 (1.27-2.75)</td>
</tr>
<tr>
<td>Side</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>51/925 (5.5)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>64/1599 (4.0)</td>
<td>0.71 (0.49-1.03)</td>
<td></td>
</tr>
<tr>
<td>Recurrent hernia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>67/1919 (3.5)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>48/605 (7.9)</td>
<td>2.25 (1.56-3.26)</td>
<td>2.48 (1.68-3.65)</td>
</tr>
<tr>
<td>Bilateral hernia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>109/2314 (4.7)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6/210 (2.9)</td>
<td>0.68 (0.30-1.54)</td>
<td></td>
</tr>
<tr>
<td>Type of repair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suture</td>
<td>60/938 (6.4)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Mesh plug</td>
<td>18/436 (4.1)</td>
<td>0.73 (0.43-1.25)</td>
<td>0.60 (0.35-1.03)</td>
</tr>
<tr>
<td>Inguinal mesh</td>
<td>23/553 (4.2)</td>
<td>0.88 (0.54-1.43)</td>
<td>0.71 (0.43-1.16)</td>
</tr>
<tr>
<td>Preperitoneal mesh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td>6/250 (2.4)</td>
<td>0.47 (0.20-1.08)</td>
<td>0.28 (0.12-0.65)</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>8/347 (2.3)</td>
<td>0.45 (0.21-0.94)</td>
<td>0.31 (0.15-0.67)</td>
</tr>
<tr>
<td>Bowel resection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>115/2511 (4.6)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0/13 (0)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Intra-operative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>complication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>114/2508 (4.5)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1/16 (6.3)</td>
<td>1.27 (0.18-9.07)</td>
<td></td>
</tr>
<tr>
<td>Postoperative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>complication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>98/2241 (4.4)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>17/283 (6.0)</td>
<td>1.37 (0.82-2.29)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Standardized 30-day mortality rate (SMR) after surgery for femoral hernia, based on 2,894 repairs registered in the SHR, 1992-2004.

<table>
<thead>
<tr>
<th></th>
<th>Elective Repairs</th>
<th>Emergency Repairs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Deaths</td>
<td>Number of Repairs</td>
</tr>
<tr>
<td>Male</td>
<td>3</td>
<td>765</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
<td>1067</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>1832</td>
</tr>
</tbody>
</table>
Out of the 1,967 patients who were sent the IPQ, 1,461 (74.3%) returned completed questionnaires suitable for analysis. Responders were younger (median age 58 years, range 16-93) at time of repair than non-responders (median 63 years, p<0.001) and had less often had an emergency repair (30.4% vs 35.7%, p=0.025). No difference was seen in gender distribution. In the responding group 72.0% (1,052/1,461) were female. The median follow-up time was 4.7 years (range 1.5-11.8).

Seven hundred thirty-three patients (50.2% of responders) described pain severe enough to interfere with concentration during everyday activities prior to surgery. The proportion of patients who reported any pain at all pre-operatively was 81.6% (1,192/1,461). The pain had disappeared within one month after surgery for 695 patients (47.6%), and during the following two months for another 190 (13.0%). During the week preceding completion of the IPQ, 354 (24.2%) patients had felt pain, 81 (5.5%) of whom suffered pain that was severe enough to interfere with concentration during daily activities. The pain imposed difficulties in performing one or more of the specified activities for 151 (10.3%) patients. The distribution according to activity is shown in Figure 2.

The median IPQ-score among all responders was zero, and among those who had pain during the week prior to completing the IPQ it was two (IQR 1-4). The only factor associated with an increased risk for chronic pain was preoperative pain where the risk increased by a factor of 1.17 (OR, 95% CI 1.10-1.25) for each step upwards on the seven-grade ordinal scale. Time since surgery (OR 0.93, 95%CI 0.89-0.98, for each added year) and emer-
gency surgery (OR 0.54, 95% CI 0.40-0.74) were associated with decreased risk for chronic pain. Results from the risk factor analyses are reported in Table 4.

Table 4. Risk factor analysis for chronic pain after femoral hernia repair in 1 452 patients who underwent surgery 1997-2006. Odds ratio (OR) for pain during the week preceding completion of the IPQ.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Perceiving Pain</th>
<th>Univariate model</th>
<th>Multivariate model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/No. at Risk (%)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>100/406 (24.6)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>254/1046 (24.3)</td>
<td>0.98 (0.75-1.28)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤58 years</td>
<td>181/737 (24.6)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>&gt;58 years</td>
<td>173/715 (24.2)</td>
<td>0.98 (0.77-1.25)</td>
<td></td>
</tr>
<tr>
<td>Elective repair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>264/1011 (26.1)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>No</td>
<td>90/441 (20.4)</td>
<td>0.72 (0.55-0.95)</td>
<td>0.54 (0.40-0.74)</td>
</tr>
<tr>
<td>Combined hernia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>289/1198 (24.1)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>65/254 (25.6)</td>
<td>1.08 (0.79-1.48)</td>
<td></td>
</tr>
<tr>
<td>Diameter of hernia defect†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤3cm</td>
<td>273/1067 (25.6)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>&gt;3cm</td>
<td>81/292 (27.7)</td>
<td>1.12 (0.72-1.76)</td>
<td></td>
</tr>
<tr>
<td>Hernia repair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior approach</td>
<td>273/1160 (23.5)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Posterior approach</td>
<td>81/292 (27.7)</td>
<td>1.25 (0.93-1.67)</td>
<td></td>
</tr>
<tr>
<td>Surgical technique</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suture repair</td>
<td>152/667 (22.8)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>Mesh plug</td>
<td>60/269 (22.3)</td>
<td>0.97 (0.69-1.37)</td>
<td>0.88 (0.62-1.25)</td>
</tr>
<tr>
<td>Inguinal flat mesh</td>
<td>86/334 (25.7)</td>
<td>1.17 (0.87-1.59)</td>
<td>0.94 (0.68-1.30)</td>
</tr>
<tr>
<td>Preperitoneal mesh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td>38/118 (32.2)</td>
<td>1.61 (1.05-2.47)</td>
<td>1.36 (0.87-2.11)</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>18/64 (28.1)</td>
<td>1.33 (0.75-2.35)</td>
<td>1.07 (0.59-1.94)</td>
</tr>
<tr>
<td>Intra-operative complication‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>350/1433 (24.4)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2/8 (25.0)</td>
<td>1.03 (0.21-5.13)</td>
<td></td>
</tr>
<tr>
<td>Postoperative complication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>325/1330 (24.4)</td>
<td>1 (ref)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>29/122 (23.8)</td>
<td>0.96 (0.62-1.49)</td>
<td></td>
</tr>
<tr>
<td>Preoperative pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up time (years)</td>
<td>0.93 (0.89-0.98)</td>
<td>0.93 (0.89-0.98)</td>
<td></td>
</tr>
</tbody>
</table>

9 of the 1 461 responders in Paper II did not answer the question about pain during the preceding week. † Data on size of hernia was available for 1 171 patients among responders. ‡ Data on intra-operative complications were available for 1 441 of the responders.
Paper III

Among responders, 1 441 patients suitable for inclusion in the analyses were identified. Females accounted for 72.4% (1 044/1 441) of responders. Elapsed time between surgery and completion of the questionnaire was a median 4.7 years (range 1.5-11.8 years) and the median age at surgery was 58 years (range 16-94 years). The repair had been conducted as an emergency procedure in 442 (30.7%) of the patients. Reasons for non-participation, as well as eligibility criteria and response-rate are illustrated in Figure 3. Responders were younger (median 58 years compared to 62, p=0.007) and more often female (72.4% vs 67.3% female, p=0.026) than non-responders. There was no difference in proportion of emergency procedures (30.7% vs 35.2%, p=0.058) or time elapsed from surgery to commencement of the study (median 4.5 vs 4.9 years, p=0.15).

Figure 3. Flowchart of eligibility, response and inclusion in paper III.

A majority (53.1%) of patients treated as an emergency had not been aware of their hernia prior to surgery. Approximately one third of emergency patients had no groin symptoms earlier than two weeks prior to admission for surgery, and 22.9% no symptoms that they ascribed to their hernia (Table 5).
Specific symptoms from the groin for patients with planned surgery and emergency surgery, respectively, are presented in Figure 4.

Six different outcomes were tested (Table 5) for association with patient or hernia characteristics. There was a significant difference between patients who had emergency repairs and those electively treated for all outcomes. Apart from the difference between these groups, some further associations were identified in the multivariate analyses. Patients in the upper age quartile were less often aware of their hernia prior to surgery (OR 0.64, 95% CI 0.48-0.86), had less often consulted a surgeon about the hernia (OR 0.58, 95% CI 0.44-0.78), and were less often on the waiting list prior to surgery (OR 0.73, 95% CI 0.54-0.98). No differences were revealed related to gender, although a tendency bordering on significance was observed regarding awareness of hernia, where OR for females was 0.74 (95% CI 0.54-1.00). BMI was left out of the multivariate analyses, since data were only available for 33.7% of subjects. In the univariate analysis, patients with a BMI within the lowest quartile were more often aware of the hernia (OR 1.93, 95% CI 1.11-3.36).

Figure 4. Frequency of specific groin symptoms at least two weeks prior to surgery. 1,424 patients operated for femoral hernia 1997-2006 (432 emergency and 992 elective) answered the question. More than one alternative allowed for each patient.
Table 5. Logistic regression analysis regarding six items in the questionnaire. Accounting for frequency, Odds Ratio [OR] and 95% Confidence Interval [95% CI].

<table>
<thead>
<tr>
<th></th>
<th>Elective surgery*</th>
<th>Emergency surgery</th>
<th>Univariate analysis OR (95%CI)</th>
<th>Multivariate analysis** OR (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aware of hernia prior to surgery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>813/990</td>
<td>203/433</td>
<td>0.19 (0.15-0.25)</td>
<td>0.23 (0.17-0.29)</td>
</tr>
<tr>
<td>No</td>
<td>44/992</td>
<td>135/432</td>
<td>9.79 (6.80-14.10)</td>
<td>10.92 (7.28-16.40)</td>
</tr>
<tr>
<td>No symptoms at all ≥2 wks prior to surgery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>39/992</td>
<td>99/432</td>
<td>7.26 (4.91-10.74)</td>
<td>7.89 (5.11-12.18)</td>
</tr>
<tr>
<td>No</td>
<td>796/981</td>
<td>166/435</td>
<td>0.14 (0.11-0.18)</td>
<td>0.15 (0.12-0.20)</td>
</tr>
<tr>
<td>Previous consult: general practitioner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>727/978</td>
<td>123/432</td>
<td>0.14 (0.11-0.18)</td>
<td>0.15 (0.11-0.20)</td>
</tr>
<tr>
<td>No</td>
<td>576/995</td>
<td>48/440</td>
<td>0.09 (0.06-0.12)</td>
<td>0.10 (0.07-0.14)</td>
</tr>
</tbody>
</table>

*serves as reference group, OR=1 by definition. **adjusted for gender, age (<70/>70 years) and hernia anatomy (solitary femoral hernia/combined femoral and inguinal hernia)

Patients aware of their hernia prior to surgery, and who were treated as emergencies, had a shorter history of awareness of the hernia than those treated electively (Table 6). Among patients on the waiting list prior to admission for surgery, it was more common among emergencies to have been on it for less than one month (29.2% vs 12.2%, p<0.001).

Table 6. Time aware of hernia prior to surgery. Results for 1 012 patients (201 emergency and 811 elective) who reported awareness and estimated time. Number of patients (% within group).

<table>
<thead>
<tr>
<th></th>
<th>Less than one month</th>
<th>1 month – 1 year</th>
<th>More than one year</th>
<th>Cannot remember</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency repair</td>
<td>50 (24.9)</td>
<td>65 (32.3)</td>
<td>72 (35.8)</td>
<td>14 (7.0)</td>
</tr>
<tr>
<td>Elective repair</td>
<td>74 (9.1)</td>
<td>414 (51.1)</td>
<td>280 (34.5)</td>
<td>43 (5.3)</td>
</tr>
<tr>
<td>p-value*</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.73</td>
<td>0.36</td>
</tr>
</tbody>
</table>

*Pearson's chi-square test
Paper IV

There was no difference between the two treatment groups in age, BMI, ASA-score, side of the hernia or proportion of irreducible hernias. Combined hernias were more common in the open group (10.3% vs 3.1%, p=0.007).

Operative Results

Duration of surgery was shorter in the TEP group, median 60 minutes vs 70 minutes (p<0.001). Two (1.0%) cases had to be converted from laparoscopic procedure to Lichtenstein, carried out under GA. Peritoneal tears that required exsufflation of the abdominal cavity, but not conversion, was seen in another two patients (1.0%). In the LLA group, all patients were treated with a Lichtenstein repair, but five (2.6%) needed conversion to GA. Sedative agents were used in 108 (56.5%) patients. In the remaining 78 patients LA only (57 patients), or LA in combination with intravenous analgesics (21 patients, between 25 and 200 micrograms of fentanyl or equivalent). One complication was reported in each group (0.5%), both related to bleeding. In the LLA group a bleeding funicular vessel required a suture ligature. Electrocautery was used to stop bleeding from congested veins along Cooper's ligament in a patient in the TEP group.

Follow-up

In all, 378 (98.4%) patients completed the six week follow-up IPQ with no difference in response rate between groups. There was no difference in reported intensity of pre-operative pain. Patients in the TEP group reported less pain during the week preceding completion of the questionnaire (p<0.001, Figure 5).

In response to whether specific activities were difficult to perform due to pain in the operated groin, fewer patients in the TEP group reported impairment in ability to exercise and perform sports (4.2% vs 15.5%, p<0.001). The IPQ-score was lower in the laparoscopic group (p<0.001), even if the median was zero in both groups (range 0-7 for TEP vs 0-10 for LLA). There was no difference in reported consumption of analgesics or in proportion of patients who had needed sick-leave for more than a week due to pain in the operated groin.
Figure 5. Highest intensity of pain during the week preceding completion of IPQ, at follow-up six weeks after surgery. 0: No pain. 1: Pain that can be ignored. 2: Pain that does not affect activities. 3: Pain that interferes with concentration during activities. 4: Pain that interferes with most activities. 5: Pain that necessitates bed rest.
Discussion

Perfecting the outcome!

Groin hernia is a common affliction, only curable by surgery. In the ideal world, surgery for any benign condition should lead to life-long relief and never be followed by complications or adverse outcomes. Our world, however, is no more perfect when it comes to surgery than anything else. Our objective, as surgeons, must therefore always be to improve our techniques to minimize the risk for adverse outcomes. Furthermore, we must do our utmost to select the right patient to treat at the right time in terms of risk-benefit.

Groin hernia is most common among people in their sixth decade, the incidence increasing with age. With an aging population, we can expect the overall incidence to increase. Because it is so common, however, a large number of individuals in the working population are also afflicted. In addition to the medical and ethical obligations to perfect the outcome, we will also be required to do so on account of more pecuniary aspects, such as cost to society.

Mortality and emergency surgery

Groin hernia is, principally, a benign condition. The 30-day risk for death after elective surgery is no higher than in an age-matched general population \[51, 57\]. More than 95\% of groin hernias are inguinal, only requiring emergency repair in five per cent of cases. Less common are femoral hernias, accounting for 2-4\% of groin hernias\[4-6, 58\]. These, however, are clinically important in that they are prone to incarceration. In Paper I the proportion of emergency repairs was 36\%, which is in accordance with other publications\[4, 22, 59, 60\]. The frequency of emergency femoral hernia repair was higher among females and elderly patients in Paper I, which is also in agreement with previous findings\[61-63\]. A reluctance to plan elderly patients for surgery may account for their increased risk. The over-representation of women among emergency repairs may in part be explained by the fact that it was more usual for men with femoral hernias to have a concurrent inguinal hernia. Some of the male femoral hernias were almost certainly an incidental finding during elective inguinal hernia surgery. On the other hand, women also have an
increased risk for emergency intervention for inguinal hernia compared to men. Paper II also suggested that elderly patients were less often aware of their femoral hernia than younger people, even though they reported symptoms to the same extent. A tendency towards the same pattern was seen for women. Since groin hernias predominantly afflict males, females may not consider the possibility that a hernia causes their symptoms. Increasing the awareness of femoral hernia in the female population may be beneficial.

The higher mortality risk for emergency hernia repair is more marked with femoral hernias. This may be partly due to need for bowel resection, which is more common in femoral repair. Bowel resection is usually due to ischemia with subsequent inflammatory response and an increase in stress for several organs. The same reasoning can be applied to the fact that intra- and postoperative complications affected the outcome adversely. One explanation as to why older patients are at greater risk for death after emergency surgery is that they often have the burden of concurrent disease. Furthermore, their reserve capacity to cope with increased demands on organs is reduced. These findings correspond to those presented by others.

Emergency surgery for femoral hernia was clearly demonstrated to be associated with a high risk. Several publications have noted this and recommended that elective repair be made a priority. In Paper I possible steps to address this issue were outlined. They involved encouraging surgeons to shorten delay prior to planned femoral hernia repair, informing primary-care physicians of the safety, even in elderly patients, of elective repair, and informing the population about the condition. However, the natural course of femoral hernia is not well described.

Gallegos suggested that incarceration of femoral hernia was preceded by a short history of symptoms, to an even larger extent than with inguinal hernia. This implies that femoral hernia treated as an emergency may, in fact, be very different from those treated electively. Paper II investigated this possibility and found that the two groups did, indeed, give distinctly different accounts of symptoms and health-care contacts prior to surgery. A majority of emergency patients denied having been aware of their hernia prior to admission for surgery, and approximately one third denied symptoms from the groin. This is in accordance with findings in smaller studies, although others claim that the hernia is often known. Given these conditions it may be difficult to diagnose and offer elective treatment. Emergency patients who were aware of their hernia had a shorter history than electively treated patients, as supported by several studies.

It was not possible to define any patient characteristics linked to an increased risk for incarceration in Paper III. Patients with a low BMI have an over-risk for incarcerated femoral hernia according to data from the SHR. In another study there was no difference in BMI between emergency and elective patients. Regrettably, BMI had to be excluded from the multivariate analyses in Paper III, since this variable was not initially registered in the
SHR, and data was missing for one third of the subjects. A positive association between low BMI and awareness of the hernia was seen among emergency patients, probably because it is easier to notice a lump in the groin for slim persons. This category of patients had not sought medical consult more often than those with higher BMI, though.

If these patients lack symptoms and there are no characteristics associated with increased risk for incarceration, one way to achieve earlier diagnosis could be a screening program. With an incidence of approximately 200 emergency femoral repairs annually in an adult population of 7.8 million people, and acknowledging that femoral hernia often are incarcerated at diagnosis or will be soon thereafter, such a project seems unreasonable in a cost-benefit perspective.

Even though the majority of emergency patients were unaware or their hernia, and one third had no groin symptoms, ten per cent of them reported that they were on a waiting list for surgery when they were admitted for incarceration of the hernia. This is a larger proportion than in some small series 68, 73, 76, where all incarcerated femoral hernias were previously undiagnosed. Two studies observed 1%60 and 4%69, of emergency repairs on waiting lists. Close to 30% of emergency cases on the waiting list, in Paper III, stated that they had been on the list for less than one month when they were admitted. This was significantly shorter than patients who had elective repair. This lends even more credence to expedient elective repair of femoral hernia after diagnosis17.

If it is not feasible to prevent emergency surgery for femoral hernia, we must focus our efforts on minimizing adverse outcomes. One area for improvement is the time frame between diagnosis and induction of anesthesia, which in studies has been shown to be unnecessarily long73, 78, 79. Another focus should be on rapid and correct diagnosis. Both a Swedish 51 and a Danish79 study on mortality after hernia surgery found that less than two thirds of patients who later died after emergency repair of their incarcerated groin hernia, had a physical examination including the groin before they were admitted. With proper examination of patients with abdominal pain, the correct diagnosis may be made earlier and the risk for bowel resection and postoperative death reduced.

Recurrence

The recurrence rate after inguinal hernia repair has decreased substantially since the introduction and general adoption of mesh techniques and standardization of procedures80. When laparoscopic procedures were introduced they had a higher recurrence rate, but when larger mesh were employed the recurrence rates were reduced and the results now equal those in open repair.46, 81, 82 Plentiful research in the area has enabled improvements in the
techniques. The two-year recurrence rate for inguinal hernia in Sweden is below two percent.

Femoral hernia repair has yet to be investigated as fully, especially with respect to risk for recurrence. There are studies\textsuperscript{4, 58} which have failed to show a difference in risk for recurrence between suture and mesh repairs. Other studies on smaller series have shown fair results with diverse methods\textsuperscript{35, 59, 83, 84}. Large randomized trials on femoral hernia repair are difficult to conduct since this type of hernia is uncommon and often treated outside office hours. Paper I is based on prospectively gathered data from a very large patient cohort. With this number of patients, a marked difference in risk for reoperation due to recurrence between various surgical techniques was revealed. Sutured repair was used as reference on account of it being the most frequently used. Both open and laparoscopic preperitoneal mesh techniques were better, in terms of risk for recurrence, where reoperation for recurrence was used as a surrogate. Register data cannot give exact recurrence rates due to the fact that there is no specified follow-up program for these patients. Studies\textsuperscript{85, 86} indicate that the reoperation rate should be multiplied by a factor of 1.7-2.3 to give an estimate of the true recurrence rate. Since the publication of paper II, a smaller randomized study has reported results supporting the effectiveness of the preperitoneal approach\textsuperscript{87}. The SHR is not a register of repairs performed by surgeons with a special interest for hernias. It rather, with its extensive coverage, reflects the status of hernia repair in the hands of general surgeons in Sweden. It could be argued that preperitoneal mesh techniques are predominantly used by experienced hernia surgeons. Even if this is the case, at least open preperitoneal repairs are associated with a higher rate of reoperation due to recurrence than anterior repairs when taking all registered hernias (inguinal, femoral and combined) into account\textsuperscript{1}.

Adjusted for surgical technique, men and patients with recurrent hernia had an increased risk for reoperation. Recurrent hernias, whether femoral or inguinal, are prone to new recurrence\textsuperscript{4, 6}. The femoral hernia was combined with an inguinal hernia in thirty per cent of the men, which may contribute to their increased risk for reoperation. An over-presentation of males with regard to combined hernias has been described previously\textsuperscript{6}, but no difference in recurrence between genders was seen.

Femoral hernia repairs had a greater overall risk for reoperation due to recurrence than inguinal repairs, and this is supported by previous findings\textsuperscript{6}. Even surgeons with a special interest in abdominal wall surgery cannot easily gather specific technical experience when it comes to femoral hernia due to its low incidence. Furthermore, these hernias often require emergency intervention, frequently outside office hours, and there is no consensus on a standard technique that may be recommended. In Sweden the use of non-specified suture techniques has been more common with women than men\textsuperscript{1}, probably reflecting a more frequent use in femoral hernia surgery. Unspecified techniques are more common for femoral emergency procedures.
However, Paper I failed to show a difference in reoperation frequency between emergency and elective femoral hernia repairs. According to the SHR, groin hernia repairs, overall, performed as an emergency have an over-risk of 30% for reoperation due to recurrence.¹

Women have been shown to have a higher risk for recurrence, at least when treated with anterior approaches⁸⁸,⁸⁹. Femoral hernia presenting as a recurrence after previous inguinal hernia repair is more common than would be expected by their proportion of primary groin hernias. It has been suggested that a femoral hernia may be overlooked during inguinal hernia surgery⁵, if using an anterior approach. Putnis⁹⁰ has furthermore shown that concurrent femoral hernia exists in over 35% of women having inguinal hernia repair. The relatively high frequency of femoral hernias among women is the reason for the categorical recommendation that the preperitoneal approach should be used in the surgery of groin hernia in females.

The previously outlined morbidity and mortality risks associated with emergency repair constitute a strong motive for elective repair of femoral hernia whenever possible. The low incidence of femoral hernia and the increased risk for recurrence suggests that surgical treatment of these hernias should be restricted to surgeons with special interest and proficiency in preperitoneal mesh procedures.

Pain

When recurrence rates following inguinal hernia surgery decreased, largely attributed to the adoption of mesh techniques, it was possible to focus on other adverse outcomes. The one that has gained most attention is long-term pain after repair.

Preperitoneal repairs, laparoscopic in particular, are considered advantageous in terms of less risk for chronic postoperative pain⁴⁶-⁴⁸,⁹¹. For anterior repair techniques LA has been shown to be associated with less postoperative pain⁴⁹,⁵⁰,⁹². Few studies have been conducted where one specific method is compared with another. Many studies compare groups of techniques with each other⁹³-⁹⁵. Other studies have compared two specific surgical techniques such as Lichtenstein and TEP, but without specifying what form of anesthesia that was to be used.⁴⁶,⁹⁶

In order to provide a firm recommendation on the procedure of choice for an affliction, one should compare candidates while making use of their particular advantages. In Paper IV the laparoscopic TEP procedure is compared to Lichtenstein performed under LA. Only experienced surgeons participated. The techniques were in use at both participating units, and medical personnel were accustomed to both procedures. Patients were randomized immediately prior to surgery in order to rule out any differences due to operating conditions.
Complication in the form of recurrence was assumed to be infrequent in both groups. Intra-operative complications were rare and there was no difference between groups. This is in contrast to some studies where surgeons have not been equally experienced in the two intervention arms\(^4\). The outcome of interest was postoperative pain. Six weeks after surgery LLA was associated with more pain than TEP. A difference in ability to perform sporting activities was seen as a consequence. LA has an obvious effect in the short term, but in theory, this form of anesthesia could also force surgeons to use a less traumatic dissection technique. This could be reflected in less pain for some weeks during the early postoperative period, though this effect could not be demonstrated when compared with TEP. Studies comparing TEP with open repair, but under different forms of anesthesia, show an earlier return to normal daily activities\(^{46, 47, 94, 95, 97}\) and work\(^{98, 99}\) after TEP. When using a rather blunt instrument for measurement of sick-leave, no difference could be seen between groups in Paper IV.

TEP was a safe method that enabled return to more strenuous everyday activities, such as sports, earlier than with LLA, and resulted in less pain at follow-up six weeks after surgery. Today the EHS recommends laparoscopic hernia repair, preferably TEP, in patients who depend on short convalescence\(^1\). The results in Paper IV support this recommendation and, considering the demonstrated safety and shorter operating time an extension of indications, given surgeons who are proficient, may be anticipated.

Chronic pain after femoral hernia surgery has been less extensively investigated. It is not evident that the pattern of pain should be the same after femoral as after inguinal hernia surgery, considering the differences in anatomy and patient characteristics. The reduced risk previously seen with preperitoneal techniques for inguinal hernia\(^{42, 93, 48, 100}\), was not seen in Paper II regarding femoral hernias. The univariate analysis, in fact, indicated an increase in risk for chronic pain after open preperitoneal mesh repair. However, this technique was more frequent in the latter part of the study period, and when adjustment for time of follow-up was made, no difference was seen. Earlier studies\(^{45}\) demonstrated that the prevalence of chronic pain diminishes with time, a finding supported by Paper II.

The risk for chronic pain was less after emergency repair. Incarceration of bowel and need for resection is common in femoral hernias treated as an emergency\(^{51, 63, 65}\). It is possible that the emergency situation, with imminent or manifest bowel ischemia, left the surgeon reluctant to perform an extensive dissection as would be the case in the normal elective repair situation. If so, the surgical focus would have been on damage control rather than permanent reconstruction. An approach either by laparotomy and/or infrainguinal repair would leave the nerves in the groin unaffected and would not involve inguinal muscles, and might thus lead to less neuropathic and motion-related pain. Another reason for this difference may be that emergency
patients are operated on regardless of previous pain status, whereas preoperative pain may play at least a part in the selection of elective cases. A high degree of preoperative pain was associated with an increased risk for chronic pain though careful interpretation is called for since the study was based on retrospective data. The impact of preoperative pain on the risk for chronic postoperative pain has been observed in other studies as well\textsuperscript{42, 101}. The accordance with previous studies, and the fact that there was no difference between patients operated during the first and last five years of the study period, however, makes the link between pre- and long-term postoperative pain more credible. The reason behind that link remains undisclosed, though.

Patients reported slightly less occurrence of pain at long-term follow-up after femoral hernia repair, than has previously been seen after inguinal hernia repair, but the frequencies for pain interfering with daily activities are very similar\textsuperscript{42}. Chronic pain must be considered an adverse outcome after femoral hernia surgery, as it is with inguinal hernia surgery. The relationship between preoperative and postoperative pain must be further investigated in order to provide information that could have a bearing on the treatment of patients. Even if the benefits of preperitoneal techniques in terms of postoperative pain could not be demonstrated for femoral hernias, no other method has shown better results. We thus recommend preperitoneal mesh repair for femoral hernia, based on lower recurrence-rates.
Conclusions

- Femoral hernias are more common in women and risk for incarceration is increased for women. Femoral hernias are often treated as an emergency. Incarcerated femoral hernias have a higher risk for bowel resection and postoperative mortality than their inguinal counterparts. The cumulative risk for reoperation due to recurrence is higher after repair of a femoral than an inguinal hernia. The preperitoneal mesh techniques have the lowest technique-associated risk for recurrence.
  - Great effort should be made to operate femoral hernias electively and with a preperitoneal mesh technique.

- Long-term postoperative pain following femoral hernia repair is a reality, just as it is after inguinal hernia surgery. There is no evidence for an association between surgical technique and risk for long-term postoperative pain in femoral hernia surgery.
  - The surgical technique of choice in femoral hernia repair should be directed by risk for recurrence, since the risk for long-term pain provides little guidance.

- Femoral hernias treated as an emergency differ from those treated electively. Patients who have emergency surgery for femoral hernia are often unaware of their hernia. A history of symptoms is frequently absent, and those aware of their hernia have been so for only a short period of time.
  - Because of low prevalence and lack of symptoms it is not feasible to create a cost-effective screening program, or recommend some other intervention within routine health-care, that would eliminate or markedly reduce the incidence of emergency femoral hernia repairs. Attention should instead be focused on prompt treatment at the emergency department.

- TEP is as safe as Lichtenstein under local anesthesia, and with as few complications. Patients have less pain six weeks after TEP than after LLA. This difference in pain also affects the patients' ability to perform daily activities.
  - A widening of indications for TEP in primary inguinal hernia repair seems justifiable, given surgeons proficient in this technique.

Ljumskbråck är den klart vanligaste typen och de är 10 gånger vanligare hos män än hos kvinnor. Endast ca 3% av bråck i ljumskn är lårbråck och de skiljer sig på många sätt från ljumskbråck. Lårbräcken är vanligare hos kvinnor än hos män och drabbar ofta äldre personer.


Syftet med denna doktorsavhandling är att identifiera riskfaktorer för ofördelaktiga utfall efter operation för lår- och ljumskbråck och att föreslå metoder att förbättra behandlingen av patienter med bråck.

Svenska Bråckregistret
I Sverige finns, sedan 1992, ett nationellt register, Svenskt Bråckregister (SBR), där data om ljumskbräckoperationer på vuxna (över 15 år) föröns. Uppgifter som noteras är fakta om patienten (ålder, kön, BMI, funktionsstatus), fakta om bräcket (förstagångsbräck/återfallsbräck, sida, storlek, typ) och fakta om operationen (akut/planerad, typ av operation,
använda material, operationstid, komplikationer). Samtliga fall registreras med personnummer, vilket gör att man kan se om patienten behövt opereras om i ljumsken och i så fall varför och hur lång tid efter den första operationen. Sedan starten har SBR vuxit till att nu omfatta mer än 95% av de operationer för bräck i ljumsken som utförs i Sverige.

SBR är ett kvalitetsregister och resultat återkopplas bland annat till deltagande kliniker för kvalitetsutveckling. Data från registret används även för forskning. Att uppgifter från så många patienter finns samlade gör det lättare att identifiera faktorer som påverkar resultatet av operationen. Detta, i sin tur, gör att generella slutsatser kan dras som påverkar vården av patienter med bräck i ljumsken inte bara vid kliniker som är med i SBR och inte bara i Sverige.

Delarbete I


Fem år efter operation hade 6,6% av de lårbråckopererade och 4,2% av de ljumskbråckopererade behövt opereras om på grund av återfallsbräck. Vid jämförelse mellan operationsmetoder för de lårbråckopererade var risken för återfall minst om man hade reparerat bråcket genom att lägga in ett nät mellan bukhinnan och bukväggens muskler.

Nästan 40% av patienterna med lårbråck opererades akut. Akut operation var vanligare bland kvinnor och äldre patienter. När man jämför patienter med akutopererade lårbråck med en icke-opererad, ålders- och könsmatchad befolkning är risken att dö inom 30 dagar från operationen 10 gånger förhöjd. Vid planerade operationer finns ingen ökad risk. Den höga risken beror på att blodflödet till tarm som satt fast i bråcket i en fjärdedel av fallen hade blivit så stort att man var tvungen att ta bort en bit av tarmen. En sådan blodflödesstörning resulterar i produktion av vävnadsskadande ämnen och inflammation som medför en stor belastning på kroppen.

Delarbete II

Smärta ett par år efter operation finns hos 30% av ljumskbråckpatienter. Mellan 5 och 10% har smärta som påverkar deras koncentration vid dagliga aktiviteter. Avsikten med detta delarbete var att undersöka förekomsten av långvarig smärta hos lårbråckopererade och försöka identifiera eventuellt påverkbara riskfaktorer. En enkät skickades ut till patienter vars operation för lårbråck hade registrerats i SBR, där de tillfrågades om smärter i den opererade ljumsken.

Det hade gått mellan 1,5 och 12 år sedan operationen när patienterna besvarade enkäten. En fjärdedel uppgav att de hade haft ont i den opererade ljumsken under den gångna veckan och 5,5% angav att smärtorna hade påverkat deras koncentration vid dagliga göromål. Man såg också att färre hade ont ju längre tid det gått sedan operationen. De som angav att de hade haft mycket ont före operationen hade också större risk för långvarig smärta efter operationen. Det fanns ingen koppling mellan operationsmetod och risken för smärta.

Kronisk smärta efter operation förekommer efter lårbråcksoperation i ungefär samma utsträckning som efter ljumskbråcksoperation. Ingen kirurgiskt påverkbar riskfaktor för utveckling av smärta kunde identifieras.

Delarbete III

I delarbete I fann vi att det var vanligt med akuta operationer hos patienter med lårbråck och att detta var förknippat med kraftigt ökad dödlighet i anslutning till operationen. Därför skickade vi en enkät med frågor om symptom och sjukvårdskontakter till patienter som hade opererats för lårbråck, akut eller planerat, och som fanns med i SBR.

Det var tydliga skillnader i svaren från de som hade opererats akut och de som hade genomgått en planerad operation. Bland de akutopererade var det mer än hälften som inte hade känt till sitt bråck, och en tredjedel som inte hade haft några symptom alls från ljumsken, före det insjuknande som krävde akut operation. De akutopererade som kände till sitt bråck hade gjort det en mycket kortare tid än de som opererades planerat.

Denna studie visar att det är svårt att förebygga akuta operationer för lårbråck, och därmed minskas dödligheten i samband med sådana, genom att ställa diagnosens tidigare och operera patienterna planerat. För att minska problem förknippade med akuta operationer bör man istället fokusera på snabbt omhändertagande och åtgärd i samband med ett akut insjuknande.
**Delarbete IV**

Vid ljumskbråck har man tidigare sett att det finns fördelar med laparoskopiska (“titthåls”) operationer gentemot operationer där man gör ett snitt i ljumskens. Fördelaktigheten gäller framför allt mindre smärta efter operationen, och skillnaden har tydligast visats för de första 2-3 åren efter operation. Det finns dock studier som har visat att öppna operationer som görs under lokalbedövning är mindre behäftade med smärta än de där patienten sover eller har fått ryggbedövning. De laparoskopiska metoderna kräver att patienten är fullt sövd.


Det var mycket ovanligt med komplikationer vid operation såväl med TEP som med Lichtenstein. Patienterna som hade opererats med TEP hade mindre ont sex veckor efter operation än de som hade opererats med Lichtenstein. Något färre än 9% av dem som hade opererats med Lichtenstein hade smärtor som påverkade deras koncentration vid dagliga aktiviteter, jämfört med 3% av dem som hade opererats med TEP. Skillnaden synliggjordes även i att det var färre i TEP gruppen som upplevde att smärtan i ljumskens hindrade dem från att motionera/utöva idrott. Det var ingen skillnad i sjukskrivning eller användande av värkmedicin mellan grupperna.

TEP är en säker operationsmetod som är behäftad med mindre smärta sex veckor efter operation än Lichtenstein, även om denna utförs i lokalbedövning. Indikationerna för att använda TEP kan utvidgas, förutsatt att kirurger som kan tekniken finns tillgängliga.
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Simon and Marcus, for being the brightest shining stars in my universe.
References


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# Appendix A

## Inguinal Pain Questionnaire

1. Date of completion: 

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| 2. Estimate the pain you felt in the groin before the surgery. | 1. No pain  
2. Pain present, but can easily be ignored  
3. Pain present, cannot be ignored, but does not interfere with everyday activities  
4. Pain present, cannot be ignored, interferes with concentration on chores and daily activities  
5. Pain present, cannot be ignored, interferes with most activities  
6. Pain present, cannot be ignored, necessitates bed rest  
7. Pain present, cannot be ignored, prompt medical advice sought |
| 3. Estimate the pain you feel right now in the groin on the same side as the operation. | 1. No pain  
2. Pain present, but can easily be ignored  
3. Pain present, cannot be ignored, but does not interfere with everyday activities  
4. Pain present, cannot be ignored, interferes with concentration on chores and daily activities  
5. Pain present, cannot be ignored, interferes with most activities  
6. Pain present, cannot be ignored, necessitates bed rest  
7. Pain present, cannot be ignored, prompt medical advice sought |
| 4. Estimate the worst pain you felt in the operated groin during this past week. | 1. No pain  
2. Pain present, but can easily be ignored  
3. Pain present, cannot be ignored, but does not interfere with everyday activities  
4. Pain present, cannot be ignored, interferes with concentration on chores and daily activities  
5. Pain present, cannot be ignored, interferes with most activities  
6. Pain present, cannot be ignored, necessitates bed rest  
7. Pain present, cannot be ignored, prompt medical advice sought |
| 5. If you answered "no pain" to question 4 try to remember when the pain in the operated groin disappeared after the operation | 1. The pain in the operated groin disappeared within 1 month after the operation  
2. The pain in the operated groin disappeared 2-3 months after the operation  
3. The pain in the operated groin disappeared 4-6 months after the operation  
4. The pain in the operated groin disappeared 7-12 months after the operation  
5. The pain in the operated groin disappeared 13-24 months after the operation  
6. The pain in the operated groin disappeared recently |

To be answered by those who have had pain during the preceding week:

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| 6. How often have you felt pain in the operated groin during the past week? | 1. Once  
2. 2-5 times  
3. Every day  
4. Every day and also during night time  
5. I have had pain the whole week, both day and night |
| 7. How long have the episodes of pain in the operated groin lasted in the past week? | 1. 1 min to 1 hour  
2. 1 to 5 hours  
3. The whole day  
4. Day and night  
5. The pain has lasted the whole week, day and night |
8. Do you find it difficult to get up from a low chair due to the pain in the operated groin?

9. Do you find it difficult to sit down for more than half an hour due to the pain?

10. Do you find it difficult to stand up for more than half an hour due to the pain?

11. Do you find it difficult to go up or down stairs due to the pain?

12. Do you find it difficult to drive a car due to the pain?

13. Has the pain limited your ability to exercise or perform sports?

| 1. No | 2. Yes | 3. I don't know | 4. Not applicable |

14. Have you on any occasion during the past week taken pain killers for the pain in the operated groin?

| 1. No | 2. Yes |

15. To what extent has the pain in the groin limited your working capability in the last 2 months?

| 1. I have not needed to take sick leave | 2. The pain made me take 1-7 days of sick leave | 3. The pain made me take sick leave for 1-4 weeks | 4. The pain has made me take sick leave for the entire past two months | 5. I have a disability pension because of the pain in the groin | 6. I am not working for other reasons. |

To be answered by everybody:

16. Estimate the severity of pain that you feel right now in the groin opposite to the operated side

| 1. No pain | 2. Pain present, but can easily be ignored | 3. Pain present, cannot be ignored, but does not interfere with everyday activities | 4. Pain present, cannot be ignored, interferes with concentration on chores and daily activities | 5. Pain present, cannot be ignored, interferes with most activities | 6. Pain present, cannot be ignored, necessitates bed rest | 7. Pain present, cannot be ignored, prompt medical advice sought |

17. Estimate the worst pain that you have felt in the groin opposite to the operated side during this past week

To be answered by male patients: Have you experienced testicular pain on the same side as the operated groin since the operation?

| 1. No | 2. Yes |

Have you been operated on for another hernia or had an abdominal operation since the hernia operation?

| 1. No | 2. Yes |
Appendix B
Questionnaire on symptoms and health-care care contacts

1. a) Were you aware of your hernia prior to admittance for surgery?
   
   No □  Yes □  Cannot remember □

   b) If so, approximately for how long had you been aware of the hernia?
   
   Less than 1 month □  1 month to 1 year □  More than 1 year □  Cannot remember □

2. Did you have any symptoms from the affected groin earlier than 2 weeks prior to admittance for surgery? (Multiple answers are allowed)
   
   Yes, a lump in the groin □
   Yes, a dull pain □
   Yes, the sense of a pulling weight □
   Yes, discomfort □
   Yes, pain radiating to the thigh □
   No, no symptoms from the groin □
   Cannot remember □

3. Did you have any other symptoms that you believe were related to the hernia? (Multiple answers are allowed)
   
   Yes, abdominal pain □
   Yes, other: □
   No, no other symptoms □
   Cannot remember □

4. Had you consulted a general practitioner about the hernia prior to admittance for surgery?
   
   No □  Yes □  Cannot remember □

5. Had you consulted a surgeon about the hernia prior to admittance for surgery?
   
   No □  Yes □  Cannot remember □

6. a) Were you on the waiting list for hernia repair prior to admittance for surgery?
   
   No □  Yes □  Cannot remember □

   b) If so, for approximately how long had you been on the waiting list?
   
   less than one month □  6-12 months □
   1-3 months □  over 12 months □
   3-6 months □  Cannot remember □
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