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**“ΕΛΑΧΙΣΤΑ ΕΠΕΜΒΑΤΙΚΗ ΧΕΙΡΟΥΡΓΙΚΗ, ΡΟΜΠΟΤΙΚΗ**  
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**ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ**  
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**ΘΕΜΑ:**

*Laparoscopic Versus Open Anterior Abdominal Wall Hernia Repair*

**ΜΕΤΑΠΤΥΧΙΑΚΟΣ ΦΟΙΤΗΤΗΣ:**

**ΑΝΤΩΝΙΟΣ Π. ΡΑΥΤΟΠΟΥΛΟΣ**

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**ΠΡΑΚΤΙΚΟ ΚΡΙΣΕΩΣ**  
**ΤΗΣ ΣΥΝΕΔΡΙΑΣΗΣ ΤΗΣ ΤΡΙΜΕΛΟΥΣ ΕΞΕΤΑΣΤΙΚΗΣ ΕΠΙΤΡΟΠΗΣ ΓΙΑ**  
**ΤΗΝ ΑΞΙΟΛΟΓΗΣΗ ΤΗΣ ΔΙΠΛΩΜΑΤΙΚΗΣ ΕΡΓΑΣΙΑΣ**  
**Του Μεταπτυχιακού Φοιτητή Αντώνιου Π. Ραυτόπουλου**

**Εξεταστική Επιτροπή**

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Η Τριμελής Εξεταστική Επιτροπή η οποία ορίστηκε από την ΓΣΕΣ της Ιατρικής Σχολής του Παν. Αθηνών Συνεδρίαση της .....<sup>ης</sup> ..... 20..... για την αξιολόγηση και εξέταση του υποψηφίου κου Αντώνιου Ραυτόπουλου, συνεδρίασε σήμερα .../.../....

Η Επιτροπή διαπίστωσε ότι η Διπλωματική Εργασία του **κ. Αντώνιου Ραυτόπουλου** με τίτλο: «Laparoscopic versus open anterior abdominal wall hernia repair», είναι πρωτότυπη, επιστημονικά και τεχνικά άρτια και η βιβλιογραφική πληροφορία ολοκληρωμένη και εμπεριστατωμένη.

Η εξεταστική επιτροπή αφού έλαβε υπ' όψιν το περιεχόμενο της εργασίας και τη συμβολή της στην επιστήμη, με ψήφους ..... προτείνει την απονομή του Μεταπτυχιακού Διπλώματος Ειδίκευσης (Master's Degree), στον παραπάνω Μεταπτυχιακό Φοιτητή.

Στην ψηφοφορία για την βαθμολογία ο υποψήφιος έλαβε για τον βαθμό «ΑΡΙΣΤΑ» ψήφους ....., για τον βαθμό «ΛΙΑΝ ΚΑΛΩΣ» ψήφους ....., και για τον βαθμό «ΚΑΛΩΣ» ψήφους ..... Κατά συνέπεια, απονέμεται ο βαθμός «.....».

Τα Μέλη της Εξεταστικής Επιτροπής

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***Η διπλωματική εργασία αφιερώνεται  
στην οικογένειά μου!***



*Θερμές ευχαριστίες!*  
*Στον Καθηγητή Χειρουργικής κι Επιστημονικό Υπεύθυνο του Π.Μ.Σ*  
*κ. Τσιγκρή Χρήστο,*  
*καθώς και*  
*στον Αναπληρωτή Καθηγητή Χειρουργικής κ. Νικητέα Νικόλαο*  
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*συνεργασία και τη στήριξή της.*

# INTRODUCTION

Hernias of the abdominal wall are very common surgical problems. In this research analyzed the comparison of laparoscopic and open procedure of the anterior abdominal wall hernias, based on analyzed procedures.

Giving the definition, a hernia is a protrusion of abdominal content (preperitoneal fat, omentum or abdominal organs) through an abdominal wall defect.

Anatomically the most important features of a hernia are the hernial orifice and the hernia (peritoneal) sac, if present. The hernial orifice is represented by the primary defect in the aponeurotic layer of the abdomen, and the hernial sac by the bulging peritoneum. The neck of the hernial sac is located at the hernial orifice. As the French anatomist Henri Fruchaud (1894-1960) already stated, hernias of the abdominal wall occur in areas where aponeurosis and fascia are lacking the protective support of muscles (Fruchaud, 1953). Most of these weak areas are anatomically present in the abdominal wall congenitally, others may be acquired during life, for example by surgery.

The uncovered weak aponeurotic areas are subject to elevated intra-abdominal pressures and give way if they deteriorate or represent anatomic varieties. The common sites of herniation of the abdominal wall are the groin, the umbilicus, the linea alba, the semilunar line of Spiegel, the diaphragm and surgical incisions. In addition, more exceptionally obturator hernias and hernias of the triangle of Petit are also encountered.

Hernias can broadly be classified into congenital and acquired types. Congenital hernias typically occur at the groin, although they may be observed at other locations such as the umbilicus or diaphragm. Abdominal wall hernias represent a common issue in general surgical practice.

The definitive treatment of all hernias, regardless of their origin or type, is surgical repair. It is suggested that a strategy of watchful waiting rather than surgery can be considered in patients with asymptomatic or minimally symptomatic inguinal and incisional hernia. The risks of delayed surgery are primarily related to the risks of incarceration and strangulation, which necessities emergency surgery. Elective surgical repair should be considered if the hernia is symptomatic, in case of an increased risk for incarceration or if the size of the hernia complicates dressing or activities of daily living. Hernias that are less likely to incarcerate include upper abdominal hernias, hernias with an abdominal wall defect larger than 7-8cm and hernias less than 1 cm in diameter. The



likelihood of incarceration decreases as the hernia defect increases in size since it is less likely that intestinal or visceral contents will become caught by a narrow neck of the hernia sac. In large incisional ('giant') hernias more skin problems (ischemia, necrosis and ulcerations) are observed and represent an indication for operation.

The chronology of the surgical treatment of hernias is already performed since Hellenistic times when Celsus performed hernial sac extirpations. The founder of modern hernia surgery is Bassini from Padova (Italy), who performed the first anatomic hernia groin repair in 1887 (Bassini, 1887). The results of anatomical hernia repair were a large step forward, however recurrences kept frustrating surgeons since. Over the last decades it has become clear that prosthetic reinforcement by a non-resorbable synthetic polymer mesh is required for most hernia repairs. Abdominal wall hernias can be repaired with mesh reinforcement by open or laparoscopic approach. The first report of the use of a laparoscope in the repair of an abdominal wall hernia was made by Ger in 1982 (Ger, 1982). Bogojavalensky in 1989 was the first to report on the use of a prosthetic mesh during laparoscopic hernia repair (Bogojavalensky, 1989).

The objective of successful hernia repair is achieving a cost-effective repair with a low recurrence rate, minimal operative and acute and chronic postoperative pain with a rapid return to normal activities. Laparoscopic repair has the potential benefits of smaller wounds, with less wound infections and better cosmetic results, and the possibility to perform the procedure in the outpatient clinic. Patients are thought to experience less postoperative discomfort and a faster recovery time. Additional benefit, especially in incisional hernia surgery, is the possibility to diagnose and treat multiple hernias in one procedure. During laparoscopic repair a mesh is placed intraperitoneally which makes contact between the mesh and viscera inevitable. The contact with the viscera can lead to adhesion formation and associated complications like small bowel obstruction, enterocutaneous fistula, infertility and chronic pain. Other possible complications of the laparoscopic approach in general are bowel and bladder injuries, artery laceration, neuralgia and trocar site herniation. During laparoscopic hernia repair it is hardly ever possible to restore functional anatomy of the abdominal wall and manage skin redundancy or the hernia sac.

The risk of recurrence is determined by surgical-technical factors (i.e. mesh use, choice and placement), the experience of the surgeon, the occurrence of a wound infection and patient related factors. Literature shows that recurrence rates are low in experienced hands. Several co-morbidities have been identified that increase the risk of recurrence and wound infection following hernia repair: smoking, diabetes, coronary

artery disease, chronic obstructive pulmonary disease (COPD), nutritional status, immunosuppression, chronic corticosteroid use, low serum albumin, obesity and advanced age. A prolonged operative time and the use of an absorbable synthetic mesh are also significant independent predictors of wound infection and associated recurrences.

Ventral hernias result from defects in the ventral abdominal wall and are typically classified by etiology and location. They can develop as a result of prior surgery (incisional and trocar site hernia) or at anatomical congenital weak locations (umbilical, epigastric and Spigelian hernia).

The abdominal wall exists of five muscles (external oblique, internal oblique, transversus abdominis, rectus abdominis and pyramidal muscles) that protect the viscera. Herniation of the abdominal wall during activity is prevented by the transverse abdominal muscles. In adults the external oblique muscle is aponeurotic up to the level of the umbilicus. The caudal boundary of the posterior layer of the rectus sheath is the linea semicircularis, usually located 5 cm caudally to the umbilicus. Cranially to it, the medial aponeuroses of the three lateral muscles give rise to the anterior and posterior layers of the rectus sheath, enveloping the lateral border of the rectus sheath. Cranially to the umbilicus, the muscular part of the transversus abdominis muscle extends more medially than the muscular parts of the oblique muscles. Cranially to the umbilicus the abdominal cavity has an integral muscular cover, except for the linea alba in the midline. Caudally to the umbilicus, the medial borders of the external oblique and transversus abdominis muscles decline laterally, and the medial border of the internal oblique muscle medially. The transversus abdominis muscle is connected to the rectus sheath by its aponeurosis, the fascia of Spigel, which is cutaneously represented by the linea semilunaris.

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# AIMS AND CASES

The primary objective of this review is to compare the clinical results of laparoscopic versus open surgical techniques for the repair of primary anterior abdominal wall hernias or incisional hernias.

The material must be reactive enough to stimulate fibroblast ingrowth, yet inert enough to minimize foreign body reaction, adhesion formation, allergic reaction and to avoid infection.

The mesh must have enough strength to prevent early recurrence but enough flexibility to accommodate activity. The mesh should also have optimal laparoscopic handling characteristics. Until now the ideal mesh does not exist and the location of implantation (intra- or extraperitoneally) should be taken into account when choosing a mesh. When choosing a synthetic mesh for laparoscopic hernia repair it is important to consider all characteristics that generate the host response, like absorbability, pore size and weave. The basic criteria for the choice of a mesh are: Absorbability. Pore size. Weave Anti-bacterial or anti-adhesive treatment.

Biological meshes made of donor collagen (porcine, bovine or human) are suggested to be used especially in a contaminated or infected environment when closure is required. These new developed collagen meshes are thought to be replaced by the patient's own collagen in time (remodelling), with an associated low adhesion formation and low infection risk.

## Pathophysiology of abdominal wall hernias

The most common hernias develop at sites where the abdominal wall strength to with-stand the intraabdominal pressure is lower, such as the internal inguinal ring, the umbilicus and previous surgical entry sites. The cause of abdominal wall hernias is probably multifactorial, with one or more factors applying in any particular case.

Many factors increase the pressure in the abdominal cavity, such as obesity, coughing with chronic lung disease, straining and ascites have traditionally been considered important in the etiology of abdominal hernias. Physical activity may be a risk factor to acquiring an inguinal hernia. Related physical exertion may increase intraabdominal pressure in combination with a patent processus vaginalis or through age related weakness of abdominal wall musculature.

Other important factors are those which are related with the integrity of the abdominal wall. The collagen fibers make up its tissues and give its strength. The ability of the abdominal wall to withstand and the

pathologic elevation in the intraabdominal pressure is related with the stand of the collagen fibers.

Cigarette smoking is another factor. Read et al found that substances in cigarette smoke inactivate antiproteases that lead to an increase in the level of circulating proteases and elastases causing destruction of the extracellular matrix of the rectus sheath and fascia transversalis thus predisposing to herniation.

An increase in the level of circulating proteases and elastases also occurs in stress situations and systemic illnesses product of an enhanced leukocyte response leading to a relative decrease in antiprotease activity.

There are also general factors such as weakening of the muscles and fasciae with advancing age, lack of physical exercise, multiple pregnancies, and loss of weight and body fitness as may occur after illness, operation or prolonged bed rest.

### Inguinal hernia

The inguinal hernia is one of the most frequently occurring hernias with an estimated 20 million hernias repair operations around the world. Estimated incidence rate in the UK is 13 per 10,000 population per year (Primates & Goldacre, 1996). Indications for laparoscopic hernia repair are debatable. In case of a primary unilateral hernia an open mesh procedure is currently recommended by the European Hernia Society because of lower recurrence rate, costs and the possibility of local anaesthesia when compared with laparoscopic repair. From a socio-economic perspective, an endoscopic procedure is probably most cost-effective in patients participating in labor, especially in bilateral hernia. Furthermore chronic postoperative inguinal pain seems to be less generated by laparoscopic repair compared to conventional technique. All patients fit for general surgery without significant contraindications, including extreme age or significant cardiac, pulmonary or systemic illness, should be offered the option of a laparoscopic hernia repair.

### Anatomy of the groin

In the male within the 'triangle of doom' between the testicular vessels and vas deferens, the external iliac vessels are encountered. They are enveloped by lymphatic and fatty tissue. The deep circumflex iliac artery and vein originate from the external iliac vessels and run parallel to the iliopubic tract (ligament of Thomson), which is the thickened caudal margin of the transversalis fascia. This structure, which extends from the anterior superior iliac spine to the pubic tubercle, dorsally parallels the inguinal ligament. The latter is not visible from the posterior view.

The inferior epigastric artery and (two) veins are, especially in the laparoscopic extraperitoneal approach, the hallmark of safe exposure and

entering of the proper preperitoneal space. As the external iliac vessels are located within the endo-abdominal fascia, the inferior epigastric vessels pass to the dorsal aspect of the rectus abdominis muscles after perforation of the transversalis fascia, at the lateral boundaries of the rectus abdominis muscles. The frequently occurring accessory obturator artery and vein (corona mortis: 'circle of death'), connecting the obturator and inferior epigastric vessels, cross the superior pubic bone. They are at risk during dissection of the medial part of the pectineal ligament of Cooper, especially in femoral hernia surgery. The genital branch of the genitofemoral nerve innervates the ventral genital skin and the cremaster muscle. After having accompanied the external iliac artery on the psoas muscle, it enters the inguinal canal through the deep inguinal ring, running dorsally to the round ligament of the uterus or the testicular vessels. Laterally to the deep inguinal ring, the lateral femoral cutaneous nerve crosses dorsally to the iliopubic tract, innervating the skin at the lateral side of the thigh. The femoral branch of the genitofemoral nerve and the lateral femoral cutaneous nerve are observed within the 'triangle of pain', also known as Kathouda's 'quadrant of doom'. The triangle is located between the gonadal vessels and iliopubic tract, at Bogros' space. Bogros' space is located between the transversalis fascia of ventral abdominal wall and the iliopsoas muscles, laterally to the inferior epigastric and external iliac vessels. In this area the application of staples for mesh prosthesis fixation is hazardous. The other nerves from the lumbar plexus (iliophypogastric, ilio-inguinal, obturator and femoral nerves) are only encountered if dissection is performed between the transversus abdominis and iliopsoas muscles and the transversalis fascia. The nerves encountered in the triangle of pain from medial to lateral are the femoral branch of the genitofemoral nerve, the femoral nerve, the cutaneous branch of the femoral nerve and the lateral femoral cutaneous nerve. The anatomic landmarks and structures of importance are illustrated in the RISE (Rotterdam Institute of Surgical Endoscopy)-circle.

The contents of the inguinal canal differ between male and female. In the male the spermatic cord is surrounded by the cremasteric fascia and cremaster muscle. Within the cord, the spermatic vessels and vas deferens are surrounded by the internal spermatic fascia. The spermatic vessels are the internal spermatic (testicular) artery, the deferential artery and the external spermatic (cremasteric) artery and vein, accompanied by the venous pampniform plexus. Between the internal spermatic and cremasteric fascia, the genital branch of the genitofemoral nerve and the cremasteric vessels are observed. The external spermatic fascia envelops the cord caudally to the superficial inguinal ring. The contents of the inguinal canal in the female include the round ligament of the uterus, the

artery of the round ligament of the uterus (Samson's artery), the genital branch of the genitofemoral nerve, the ilio-inguinal nerve and lymphatics.

### Classification

To date, there is a lack of consensus among general surgeons and hernia specialists on classification systems for inguinal hernias. The traditional system classifies them into direct and indirect inguinal hernias. The persistence of a processus vaginalis is often described as a lateral or indirect hernia and a deficient transversalis fascia as a medial or direct hernia. In general clinical distinguishing is often difficult and irrelevant because treatment does not differ.

Indirect inguinal hernias are the most common groin hernias in men and women. The hernia develops at the internal ring laterally to the inferior epigastric artery, in contrast to direct hernias which arise medially to the inferior epigastric vessels. Most indirect inguinal hernias are congenital, even though they may not become symptomatic until later in life. Indirect hernias develop more frequently on the right, because the right testicle descends later to the scrotum than the left.

Direct inguinal hernias occur through the transversalis fascia at (the caudal part of) Hesselbach's triangle, formed by the inguinal ligament inferiorly, the inferior epigastric vessels laterally, and the rectus abdominis muscle medially. They occur as a result of a weakness of this part of the transversalis fascia, representing the floor of the inguinal canal. This weakness appears to be most often a congenitally diminished strength of collagen.

To be able to compare results most researchers choose to classify hernias by the classification of Nyhus (Nyhus, 1993):

Type 1: Lateral/ indirect hernia with normal internal inguinal ring

Type 2: Lateral/ indirect hernia with wide internal inguinal ring and normal transversalis fascia

Type 3a: Medial/ direct hernia

Type 3b: Pantaloon- or combined hernia

Type 4: Recurrent hernia

### Open mesh techniques

Open surgical technique was popularized by Rives, Stoppa and Wantz. After taking patients to operation theater and under general anesthesia, endotracheal intubation and close monitoring, the operation started. Foleys catheter was put for patients with lower abdominal ventral hernia repair and nasogastric tube for upper abdominal hernia repair with perioperative single-dose antibiotic in form of cefotaxime. Then, after proper cleaning, painting and draping of the abdomen, the skin incision



was made according to site and size of defect, a subcutaneous flap was raised up to 3 to 5cm around the defect and after the hernia sac was found, the contents were reduced. Then posterior rectus sheath and muscle were dissected, and rectus muscle and peritoneum in the lower abdomen. The posterior rectus sheath and peritoneum were closed primarily with 2:0 absorbable suture, then polypropylene meshes of suitable size with a minimum of 3cm overlap beyond the margin of the defect were placed over posterior rectus sheath/peritoneum and rectus muscle and fixed in four corners with 2:0 polypropylene sutures taken out through abdominal muscle on the anterior rectus sheath. The anterior rectus sheath was closed over the mesh with a loop of polypropylene or nylon without tension. Then the skin was closed over the drain depending upon size and extension of the wound.

#### The open techniques (onlay, sublay and inlay)

The onlay technique was originally reported by Chevrel. In 257 cases using the adjuncts of fibrin glue and relaxing incisions in the anterior rectus sheath, he achieved low morbidity and a recurrence rate of 4.9%. Other centers have achieved similar results including patients with major hernias > 10 cm transverse diameter.

Rives developed the sublay technique and reported 183 cases with good results, recurrence of 3.4% and acceptable morbidity. Recent advocates of the technique have claimed that sublay is the ideal position for the mesh, but have not provided evidence from randomized trials. The disadvantages of the sublay are that it is more technically challenging, requiring the opening of a large space behind the rectus muscles. The first layer of abdominal closure is the posterior rectus sheath and peritoneum below the arcuate line, where potential contact between mesh and bowel is possible or peritoneal closure may be incomplete. The sublay method is only applicable to midline hernias and cannot be used in other locations which represent 20% of anterior abdominal wall incisional hernias.

The inlay technique bridges the fascial defect (similar to the approach with laparoscopic surgery) and is an inferior operation because it does not restore the anatomy and physiology of the anterior abdominal wall. The technique exposes the viscera to contact with mesh requiring an expensive double-layered mesh with an inner non-adhesive coating.

#### Laparoscopic repair

The two laparoscopic techniques that are currently most frequently performed for inguinal hernias are the transabdominal preperitoneal repair (TAPP) and the total extraperitoneal repair (TEP). Both TAPP and TEP use a mesh in the preperitoneal space as described by Stoppa to replace the visceral sac. These laparoscopic techniques were originally developed for repair of difficult and recurrent inguinal hernias, which

were known to have high recurrence rates (Stoppa et al., 1984). Performance of a laparoscopic repair may be technically challenging if the patient has had prior prostatic surgery or lower abdominal radiotherapy. Currently no indications exist in which TAPP is preferred over TEP.

One of the major challenges of laparoscopic hernia repair is to learn the anterior abdominal wall anatomy from a posterior view. This is mainly responsible for the learning curve, which is associated with an increased incidence of complications. Although preoperative complications are rare in laparoscopic repair, they occur more often early during the learning curve and are more critical. Reported complications include trocar injury to bowel and bladder, vascular injury to the inferior epigastric and femoral vessels, nerve entrapment, transection of vas deferens, and trocar site hemorrhage. After 250 laparoscopic repairs the recurrence rate is half of the rate of surgeons who have performed fewer repairs. If in future training would not be only incidental but more structurally organized with emphasis on anatomy including a defined proctorship it might be expected that learning curves will be much shorter.

### TAPP

The TAPP approach was first described by Arregui and colleagues in 1992. Performing a TAPP, firstly laparoscopic access into the peritoneal cavity is obtained. After identification of the inguinal hernia the peritoneum is incised several centimeters above the peritoneal defect. The peritoneum is incised from the edge of the median umbilical ligament toward the anterior superior iliac spine. Repair of bilateral hernias can be performed through two separate peritoneal incisions or one long transverse incision between the superior iliac spines. Subsequently the preperitoneal avascular space between the posterior and anterior fascia transversalis is dissected to provide visualization of the myopectineal orifice of Fruchaud and size of the abdominal wall defect. In case of an indirect hernia, the cord structures are isolated and dissected free from the surrounding tissues. Simultaneously, the indirect hernia sac is identified on the anterolateral side and adherent to the cord. The cord must be skeletonized with care to minimize trauma to the vas deferens and the spermatic vessels. If the sac is sufficiently small, it can be reduced into the peritoneal cavity. If the hernia sac is large it should be completely dissected and divided beyond the internal ring, and the subsequent peritoneal defect closed with an endoloop suture. The distal end of the transected sac should be left open to avoid formation of a hydrocele. When reducing a direct hernia sac, a “pseudosac” may be present, which consists of fascia transversalis that overlies and adheres to the peritoneum and invaginates into the preperitoneal space during the dissection. This

layer must be separated from the true hernia sac in order for the peritoneum to be released back fully into the peritoneal cavity. Once the pseudosac is freed, it will typically retract anteriorly into the direct hernia defect.

A large piece of mesh, of at least 15 x 10 cm, is used to cover the myopectineal orifice, including the direct, indirect and femoral hernia spaces. It is important to dissect the preperitoneal space to prevent folding of the edge of the mesh within this space. In addition the mesh should be placed with a slight overlap of the midline to ensure adequate coverage of the entire posterior floor of the groin. The intraperitoneal pressure that is evenly distributed over the large surface of the mesh keeps it in place making fixation of the mesh controversial provided that elimination of fixation does not lead to an increased rate of recurrence. The use of tackers or sutures is associated with increased chronic inguinal pain, use of postoperative narcotic analgesia, hospital length of stay and the development of postoperative urinary retention. Suitable structures for fixation are the contralateral pubic tubercle and the symphysis pubis, Cooper's ligament or the tissue just above it and the posterior rectus sheath and transversalis fascia at least 2 cm above the hernia defect. Fixation is never performed below the iliopubic tract laterally to the internal spermatic vessels, to minimize the chance of damage to the lateral cutaneous nerve of the thigh or the femoral branch of the genitofemoral nerve. Finally the mesh is covered by securing the peritoneal flap back to its original position. The peritoneum should be closed to eliminate the risk of formation of adhesions between the mesh and the intestine. The configuration of the mesh is also important. A slit in the mesh, although attractive in concept, can lead to constriction of the cord structures or allow herniation through the slit.

When using the TAPP technique, in addition to femoral hernias, especially sacless sliding fatty inguinal hernias may be overlooked because of intact peritoneum. Therefore, in cases of clinically diagnosed inguinal hernias, the preperitoneal space should be inspected intraoperatively to avoid unsatisfactory results. The main drawback of the TAPP procedure is that it requires entering of the peritoneal cavity with increased risk of injury to intra-abdominal organs. Further it requires subsequent incising the peritoneum with eventually peritoneal closure. The TEP was developed to avoid opening the peritoneal cavity with the associated risks.

### TEP

The first to describe total extraperitoneal endoscopic repair of a inguinal hernias was Ferzli in 1992. The procedure is initiated with a subumbilical incision followed by blunt dissection of the subcutaneous layer up to the

anterior rectus sheath. The anterior rectus sheath is horizontally incised and with retractors the rectus abdominis muscle is searched and gently moved aside to bring the posterior rectus sheath in sight. The dissection of the preperitoneal space up to the symphysis is continued with a balloon. When using a balloon ('space maker') the thin fibrous layer of the posterior lamina of the fascia transversalis will rupture automatically to expose the 'proper preperitoneal space'. Subsequently a blunt tipped trocar is inserted into the preperitoneal space and a pneumoperitoneum is established. Additional trocars are inserted under direct vision.

Further identification and repair of the inguinal hernia is identical to TAPP repair.

### Pre-operative preparation

Patients with major abdominal wall hernias (> 10 cm) and particularly those with loss of domain, stomas, fistulas, chronic sinuses or previous mesh should receive computed tomography (CT) scan prior to surgery. This will accurately outline the abdominal wall defect, the contents of the sac, the position of previous mesh, seromas, sinus tracks and abscesses. In obese patients, pre-operative weight loss is essential to ensure the safety of anaesthesia, to reduce postoperative complications and reduce loss of domain.

Pre-operative progressive pneumoperitoneum maintained for an average of 9 days has been used in some centers. The method is simple and involves a puncture site in the left hypochondrium with daily insufflation of ambient air of 1000–4000 cc to a maximum intra-abdominal pressure of 15 mmHg according to patient tolerance. Successful hernioplasty is then feasible in the majority of patients. There has been a failure to adopt this procedure by most centers for reasons that are unknown.

Wound infection after incisional hernia repair with mesh can be catastrophic and antibiotic prophylaxis is essential. Deep-seated infection has a serious impact on quality of life and occurs in 1–2%. The only prospective, non-randomised study reported a reduction in infection rate of 50% in those who were receiving prophylaxis.

### Acute repair

Acute repair of inguinal hernia is necessary in case of incarceration or strangulation. The cumulative probability of hernia getting strangulated after three months is 2.8%. The risks of postoperative complications following emergency surgery are high, and in elderly patients, mortality can be as high as 5%. Mostly open surgery is performed in case of incarceration to reduce the strangulated content, dissect the hernia sac and

repair the abdominal wall defect. In 1993 Watson was the first to report acute laparoscopic reduction of the hernia with resection of the bowel. This reluctance may be attributable to the technical difficulties encountered in reducing the hernia sac and contents and the increased risk for iatrogenic injuries. The overall rate of complication, recurrence and hospital stay are very close to the rates documented in open repair for incarcerated hernias.

In case of a direct hernia, a releasing incision is made in the anteromedial aspect of the defect to avoid the inferior epigastric vessels. In indirect hernias, the vessels are controlled, clipped and transected to facilitate the way for the releasing incision performed anteriorly in the deep (internal) ring at the 12 o'clock position toward the superficial (external) ring facilitating reduction of the incarcerated sac and its contents.

The laparoscopic technique might improve short-term results (less wound complications, shorter hospital stay, etc.) and give similar recurrence rates as open mesh techniques. Nevertheless, randomised controlled trials (RCTs) with a follow-up of at least 3-5 years are necessary to determine the long-term effectiveness of the procedure. Therefore, it is of major importance to review the results of the available trials systematically to compare open and laparoscopic surgery.

The large number of previous systematic reviews underlines the importance of a highquality review and meta-analysis on this topic.

### Choice of mesh

There are no long-term clinical or experimental data to support the use of most mesh products presently in use. The only randomised trial comparing light-weight mesh with standard-weight mesh in open repair reported a 17% recurrence rate for light-weight and a 7% recurrence rate for standard-weight mesh. The seroma rate for light-weight mesh using the sublay method was 34%. Abdominal wall compliance was collected in 87 patients and showed no treatment differences between light-weight and standard-weight groups indicating that the concept of the 'stiff man syndrome' or problems with compliance with standard-weight mesh in open repair is a myth.

The understanding of the indications for biological meshes is under development. There are limited clinical data and short-term follow-up. Currently, the main application is in an infected or potentially infected field where the high cost is offset by the potentially expensive complications of an infected prosthetic graft.

The problems of mesh shrinkage have been exaggerated by extrapolation from animal studies. In a clinical surveillance study of shrinkage of polypropylene mesh inserted by onlay or sublay technique, a

reduction in the calculated area of the mesh stabilised at approximately 30% at 12 months.

Therefore, a mesh of  $10 \times 10$  cm ( $100 \text{ cm}^2$ ) will reduce in size to approximately  $8 \times 8$  cm ( $64 \text{ cm}^2$ , a 36% shrinkage in area) representing a reduction in width or overlap of 2 cm, which is still sufficient to prevent recurrence at the edges of the mesh. Therefore, for open repair with complete fascial closure, no more than 5 cm overlap or a 10 cm width mesh will be required.

#### Indication of the laparoscopic and ventral hernia repair

A laparoscopic repair of an incision or ventral hernia can be considered for any individual who is stable enough to undergo a general anesthetic.

- Fascial defect size  $>3$  to 4 cm in a non obese patient
- Fascial defect  $\geq 2$  cm in obese patients
- Recurrent hernias with or without multiple defects

Most patients will fit into one of these above categories, however there are circumstances that need to be considered wherein an open procedure might be the better option such as: infected or exposed mesh, thin skin with adherence to the underlying intestine, hernias larger than 15 cm in transverse dimension, unusual locations such as denervation flank hernia, extremely extensive intraabdominal adhesions.

#### Other indications for the open procedure are:

- Multiple scars on the abdominal wall, which make intra-peritoneal access difficult.
- Large defect where 3 to 5 cm meshes overlap is not possible intra-abdominally.
- Patient with large amount of redundant skin and fat on the abdominal wall are better suited for abdominoplasty procedures.
- Infection and peritonitis.
- Acute and subacute intestinal obstruction.
- Severe cardiopulmonary disease.
- Portal hypertension.

#### Technique of laparoscopic ventral hernia repair

After establishing a pneumoperitoneum and introducing trocars, laparoscopic ventral hernia repair is started with lysis of intra-abdominal adhesions with caution to prevent bowel injury. After reduction of the hernial content, the hernia sac is commonly left in situ.

In doing so seroma formation can occur. The fascial defect is measured and a piece of mesh able to cover the defect with an overlap of at least 3 to 5 cm is cut in shape. The intraabdominal pressure should be lowered to

make the abdominal wall more natural shaped and to allow a flat placement of the mesh. The mesh is tension-free implanted and fixated with tackers (every 2 cm) and possibly additional transabdominal sutures (at least every 5 cm). Tackers can be placed in one row or a double row (double-crown technique). Drains are not typically used after laparoscopic hernia repair. Complications that can occur are related to laparoscopy (i.e. bowel injury and subsequent enterotomy), nerve injury by tackers or transabdominal sutures, adhesion formation to the mesh and fixation material, mesh infection and mesh dislocation.

### Incisional hernia

An incisional hernia develops when the fascial tissue fails to heal at the incision site of a prior laparotomy. Incisional hernia is a common complication and represents about 80% of all ventral hernias. The highest incidence of incisional hernias is observed after midline laparotomy, the most common incision for abdominal surgery. In decreasing order of incidence, incisional hernias are diagnosed after upper midline incisions, lower midline incisions, transverse incisions and subcostal incisions. Incisional hernias are also described after paramedian, McBurney, Pfannenstiel and flank incisions.

Conditions that impair wound healing make patients susceptible to the development of an incisional hernia, such as wound infection, diabetes mellitus, obesity, immunosuppressive drugs, aneurysm of the abdominal aorta, connective tissue disorders and smoking.

Approximately 15-20% of all patients will develop an incisional hernia after midline laparotomy. The incidence rises up to 35% in patients with an aneurysm of the abdominal aorta. Besides patient co-morbidities, technical failure contributes to the development of incisional hernia. After midline laparotomy the fascia should be closed with a non absorbable or slowly-absorbable continuous suture in a suture length to wound length ratio of 4:1 or more to lower the rate of incisional hernia.

Around 40% of incisional hernias are symptomatic and approximately 1 out of every 3 incisional hernias is repaired in an elective or emergency setting. In the United States, approximately 4 to 5 million laparotomies are performed annually, leading to 400,000 to 500,000 incisional hernias, of which approximately 200,000 repairs are performed.

### Classification

Different classification systems for incisional hernias are available. The European Hernia Society developed a classification for incisional hernias which takes in account the location, size and possible recurrence of the incisional hernia (Muysoms et al., 2009). This classification allows

comparison of publications and future studies on treatment and outcome of incisional hernia repair. Incisional hernias are classified by:

Location:

- Midline: M1 (subxiphoidal), M2 (epigastric), M3 (umbilical), M4 (infraumbilical) and M5 (suprapubic)
- Lateral: L1 (subcostal), L2 (flank), L3 (iliac) and L4 (lumbar)
- Width: W1 (smaller than 4 cm), W2 (4 to 10 cm), W3 (10 cm or more)
- Recurrence: yes or no

The Ventral Hernia Working Group (USA) developed a hernia grading system based on the characteristics of the patient and the wound. Using this system a surgeon can assess the risk for surgical-site occurrences (infection, seroma, wound dehiscence, and the formation of enterocutaneous fistulae) for individual patients and thereby select the appropriate surgical technique, repair material, and overall clinical approach for the patient. The grading system with assessment of risk for surgical site occurrences:

- Grade 1, Low risk: patients without a history of wound infection and a low risk of complications
- Grade 2, Co-morbid: patients with one or more co-morbidities of smoking, obesity, diabetes mellitus, COPD, immunosuppression.
- Grade 3, Potentially contaminated: patients with a previous wound infection, stoma present or operation with violation of the gastrointestinal tract.
- Grade 4, Infected: patients with an infected mesh or septic dehiscence.

Recurrence after laparoscopic repair Luijendijk (2000) and Burger (2004) stressed the importance of mesh reinforcement for incisional hernia repair, with long-term recurrence rates of 60% in the suture repair group and 32% in the mesh group. Recurrence rates following laparoscopic and open ventral hernia repair with prosthetic reinforcement are comparable. Wound infection is one of the main contributors to the recurrence rate after laparoscopic ventral hernia repair, but surgical-technical failure is underestimated. Technical failure (i.e. inadequate mesh fixation, mesh overlap and lateral detachment) accounts for approximately 50% of the recurrences and infection for an additional 25%. This explains the major decrease of recurrences in experienced hands, compared to non-experts. By laparoscopic ventral hernia repair the intraperitoneally placed mesh is pushed outward and held in place by the natural intraabdominal pressure. Another benefit of the laparoscopic approach is identifying small 171 fascial defects, known as “Swiss cheese” defects, which may be missed during open repair.



These small fascial defects are thought to be the major source of incisional hernia recurrence and therefore identification is important for a successful hernia repair.

### Trocar site hernia

Trocar site hernias (TSH) have an overall low incidence of less than 1% in adults.

The incidence of TSH increases with the size of the used trocar. Almost all TSH develop from trocars of 10 mm or above. Most TSH are located at the umbilical port site, where the largest trocars are used and the fascia is expanded to remove surgical specimen. To prevent TSH the fascia of trocar sites of 10 mm or above should be sutured with a non-absorbable or slowly-absorbable suture, especially in the umbilical area. Comorbidities as diabetes, smoking and obesity might be risk factors for TSH. The use of a Veress Needle (instead of an open introduction technique) and a sharp trocar (compared to a conical shaped trocar) are associated with a higher incidence of TSH. In young children the reported incidence of TSH is higher than in adults (5% vs 1%). Herniation of the small sized bowels through trocar ports of 3-5 mm is described, which shows the importance of closing all trocar port fascias in paediatric patients.

### Umbilical hernia

A congenital umbilical hernia develops when the umbilical scar fails to heal at birth. The incidence of congenital umbilical hernia is 10-30%, with a higher incidence in African American children than in Caucasian children. During the first 1.5 year of life most umbilical hernias close and at the age of 5 almost all children have complete closure of the umbilical ring. Repair should not be considered before an age of 3 years and only in children with large hernias that do not decrease in size or are symptomatic. In the rare case of incarceration, repair is necessary to avoid strangulation. Umbilical hernias in adults are an acquired defect in over 90% and are three times more frequently seen in women than in men. The development of an umbilical hernia is associated with obesity, abdominal distension, ascites and pregnancy. In females umbilical hernias are more frequent among multipara and are often easily reducible. Men often present with an incarcerated umbilical hernia, most often containing herniated omentum or preperitoneal fat.

Laparoscopic umbilical hernia repair with an onlay patch is a safe and efficacious technique, and compared to open repair has the advantages of a lower rate of wound complications, reduced postoperative pain, shorter hospital stay and a diminished morbidity rate. Hernia repair in the

presence of ascites due to cirrhosis should be considered elective, since emergency repair has an associated morbidity of 70% and mortality of 5%. Even in patients with mild to moderate cirrhosis correction can be safely performed.

### Epigastric hernia

An epigastric hernia is a defect in the linea alba located between the xyphoid process and umbilicus. Epigastric hernias are comparable to umbilical hernias, but smaller in size, often less than 1 cm. Epigastric hernias are acquired defects with an incidence of 3-5%, three times more frequent in men than in women and mostly diagnosed between 40-60 years. Associated factors for the development of epigastric hernias are increased intraabdominal pressure and muscle or linea alba weakness. During laparoscopy an epigastric hernia can be difficult to visualize due to lack of peritoneal involvement through the hernia defect. Frequently epigastric hernias present incarcerated and in general only contain omentum or preperitoneal fat. Because of the small defect the hernia defect mostly need to be enlarged to reduce the hernial sac and its content.

### Spigelian hernia

A Spigelian hernia is relatively rare, but more often diagnosed since the introduction of CTscan and laparoscopy.

The Spigelian hernia occurs along the semilunar line at the level of the absence of the posterior rectus sheath (semicircular line, below the umbilicus). Almost all Spigelian hernias are interparietal due to the intact external oblique aponeurosis covering the hernia. A large Spigelian hernia is most often found laterally and inferior to its defect in the space directly posterior to the external oblique muscle.

The Spigelian hernia has different factors of etiology:

- Muscular gap between linea semilunaris and medial boundaries of oblique and
- transversus abdominis muscles, caudally to umbilicus,
- Maximal width of aponeurosis of transversus abdominis muscle at crossing of
- semicircular and semilunar lines.
- Parallelism of fibers of internal oblique and transversus abdominis muscles between arcuate line and Hesselbach's triangle.
- Blending of aponeuroses of internal oblique and transversus abdominis muscle into one separate structure, caudally to arcuate line.

Clinical diagnosis of a Spigelian hernia is challenging, but imaging with ultrasonography or CT-scan will confirm the presence of the hernia. Up to 20% of Spigelian hernias present incarcerated and therefore elective repair is indicated when diagnosed. The technique of laparoscopic repair is similar to other ventral hernia repairs. Compared to open repair, laparoscopic repair of Spigelian hernias is associated with a decreased morbidity, shorter hospital stay and low recurrence rate.

## **MATERIAL AND METHODS**

A literature search was performed using search engine Google scholar and our online facility of SpringerLink.

In the research are included all randomized controlled studies, which compare laparoscopic with open repair in patients with anterior abdominal wall hernias.

Studies were included irrespective of language, publication status, or sample size. Quasi-randomized trials (for example allocation by hospital record number or date of birth) were excluded.

### Types of participants

Studies on adults suffering from anterior abdominal wall hernias. All types of hernias (i.e. inguinal, incisional, parastomal, epigastric, umbilical, spigelian) were considered.

In this retrospective study are analyzed 7 retrospective and randomized studies that compare the open versus the laparoscopic repair of the anterior abdominal wall hernias.

The 1st study occupied with fifty patients underwent laparoscopic incisional and abdominal hernia repair between September 2001 and May 2003. These patients represent the entire number of incisional and abdominal hernias that came to attention at a primary referral center. No selection of patient characteristics or hernia types was done. In 7 patients, a primary abdominal hernia, principally umbilical, was diagnosed. Patient data were recorded prospectively and noted age, sex, American Society of Anaesthesiologists (ASA) score, body mass index (BMI), previous incisional hernia repairs, operative time, hernia diameter, use of drainage, length of stay, complication rate, follow-up, and recurrence.

Follow-up consisted of an outpatient visit 1 month after the operation and a phone call as the last contact. Patients expected to have a recurrence were seen in an outpatient setting.

The historical control group consisted of 50 patients operated on between February 1998 and December 2001. They underwent an anterior

incisional hernia mesh repair and represent the last patients operated on with this technique in our department. No selection was used in choosing the group. The same data were retrospectively collected as were collected for the laparoscopic group. Follow-up consisted of telephone contact and a clinical evaluation when needed.

Patient preparation for the laparoscopic technique was accomplished with bowel washout and bowel gas reduction. A first-generation cephalosporin was given as prophylaxis.

The 2<sup>nd</sup> study: enrolled 1051 patients in the study between February 1994 and June 1995. The main analysis is based on data from 487 patients who underwent laparoscopic repairs and 507 who underwent open repairs for inguinal hernia. Randomization was successful, and the two groups were similar at base line characteristics of 994 Patients with inguinal hernias repaired with open or laparoscopic surgery. A second analysis of recurrence rates included the 8 patients who did not undergo the assigned operation (for a total of 493 patients in the laparoscopic-surgery group and 509 in the open-surgery group).

During this time, 114 eligible patients were not enrolled: 74 refused to participate, 27 could not understand the protocol, and 13 were not enrolled for a variety of reasons. Of the 1051 enrolled patients, 31 (13 assigned to the open-surgery group and 18 assigned to the laparoscopic-surgery group) decided not to undergo surgery, in most cases because of the absence of serious symptoms. Only three of these patients have subsequently undergone surgery.

Eighteen patients (8 in the open-surgery group and 10 in the laparoscopic-surgery group) were excluded. Three of these patients had bilateral repairs, four were considered to be poor candidates for general anesthesia, and three were found not to have inguinal hernias at surgery. An additional eight withdrew informed consent: two wanted open repairs, three wanted laparoscopic repairs, two refused annual follow-up, and one underwent surgery at another hospital. In addition, eight patients did not undergo the assigned procedure because of a misunderstanding between the central office and the surgeon, with six of the patients undergoing unplanned open repairs and two undergoing unplanned laparoscopic repairs.

The 3<sup>rd</sup> study which is non-randomized and prospective, involved 50 patients with ventral hernia that presented during the period of July 2006 to January 2007 in the institute (G.G. Hospital Jamnagar) and were subjected either to repair by laparoscopy or to open repair.

The 4<sup>th</sup> study selected teaching and nonteaching hospitals in rural and urban regions for this study. The sex and age distributions of the people living in these regions were similar to those in the Netherlands as a whole. The surgeons in participating hospitals enrolled patients in the study. Study was approved by the ethics committees at all the hospitals and by the Dutch Health Insurance Council, and all patients gave informed consent.

The patients were randomly assigned to either conventional anterior repair or extraperitoneal laparoscopic repair, with the assignments made at a central office. Randomization was carried out by telephone, according to a computer-generated list, in groups of 25 or 50 patients, within each of these groups, the maximal allowable difference in the number of patients assigned to the two treatments was 4. To ensure an equal distribution of patients in the two treatment groups, they were stratified according to the hospital and the type of hernia (primary or first recurrent).

All 87 surgeons and residents who performed hernia repairs using the conventional anterior approach were experienced in this technique or were supervised by an experienced surgeon. The repair consisted of a reduction of the hernia, ligation of the hernial sac, if necessary, and reconstruction of the inguinal floor with nonabsorbable sutures, if necessary. Mesh prosthesis was not used unless adequate repair was otherwise not possible.

Of the 87 surgeons and residents, 23 also performed laparoscopic repairs. They had ample experience with other laparoscopic procedures and acquired experience with this particular procedure under the supervision of experienced surgeons before they were allowed to participate in the trial.

The laparoscopic technique has been described elsewhere. It was usually performed with the patient under general anesthesia. Balloon dissection was used to develop the preperitoneal space without entering the abdominal cavity. Extensive lateral dissection was performed, with isolation and manipulation of the structures of the spermatic cord. A polypropylene mesh (10 cm by 15 cm) was placed over the myopectineal orifice. The mesh was not split and was not fixed in place. Patients were catheterized only if a full bladder was suspected. Prophylactic antibiotic therapy was not commonly given in either group.

#### Data Collection and Follow-up

Standardized data collection was performed by the attending resident or surgeon, and each patient was evaluated at the hospital monthly by a physician or data manager from the central study office. The hernia was classified as type I, II, III (subtype A, B, or C), or IV (subtype A, B, or

according to the classification of Nyhus. The operation time was defined as the time from the first incision to the placement of the last suture.

Informations are collected about multiple operative and postoperative complications. The operative complications were bleeding front epigastric or testicular vessels, injury to the vas deferens, nerve injuries, peritoneal defects or defects in the hernial sac, pneumooscrotum, and technical defects of laparoscopic instruments or equipment. Cardiovascular complications during surgery were defined as a fall in the diastolic pressure to a level below 50 mm Hg or cardiac arrhythmia. Discontinuation of the original laparoscopic procedure in favor of either a transperitoneal laparoscopic procedure or a conventional procedure was also recorded as a complication.

Postoperatively, all potential complications, such as hematoma, seroma, chronic pain, and wound infection, were assessed and documented. A serious wound infection was defined as the presence of pus or sanguinopurulent discharge at the operative site. A urinary tract infection or epididymitis was recorded only if antibiotic treatment was prescribed. Urinary retention was defined as an inability to urinate, requiring catheterization. Postoperative bleeding was recorded if compression was required to control it. The length of hospitalization, defined as the number of days in the hospital after the day of surgery, was also recorded. Patients were discharged from the hospital if there was no serious infection or bleeding, the patient was able to walk, and only oral analgesic therapy was required to manage pain.

The patients were requested to return to the outpatient clinic at one and six weeks. At six months, and at one and two years for a standardized history taking and physical examination by a resident and, in most cases, by the surgeon who had performed the surgery. The patients were asked to assess the severity of pain at the operative site every day for the first week and at two and six weeks, with the use of a 100-mm visual-analogue scale (scores ranged from 0, for no pain, to 100, for unbearable pain), and to record the use of analgesic drugs. Analgesia, initially acetaminophen (500 mg) or a nonsteriodidal anti-inflammatory drug, was given on request. Chronic pain was defined as pain in the groin, scrotum, or medial part of the thigh that was serious enough for the patient to mention at six months.

The activities of daily living were assessed with a questionnaire from a Dutch health survey. Modified to include questions applicable to patients who had undergone inguinal-hernia repairs. The scale ranged from 0 (worst score) to 100 (best score). The questionnaire was administered one day and one, two, and six weeks after surgery. The patients were also asked to record in a diary the dates on which they resumed normal daily

activity at home, returned to work, and resumed their usual athletic activities.

Since differences in advice about returning to work after inguinal hernia repair may affect the validity of this end point, all study surgeons and other personnel were instructed to give the same advice about the resumption of work and other activities. In addition, the patients' physicians received a letter explaining the trial and stating that the patients should not limit their activities but do whatever they felt able to do. All patients were either visited or contacted by telephone by a member of the central study office, who was unaware of the treatment assignments, soon after discharge to explain the importance of keeping the diary and answer any questions about the follow-up and resumption of usual activities.

Home visits by experienced physicians were also conducted one and two years postoperatively if patients were unable or did not want to go to the hospital. Follow-up data were considered complete only if they included the results of follow-up physical examinations by an experienced physician at the planned times.

### End Point

The primary end point of the study was a recurrence of the hernia, defined as a clinically detectable swelling in the groin or a clearly palpable defect of the abdominal wall in the groin, diagnosed by two physicians. If a physician was unsure whether there was a recurrence, the physical examination was repeated or ultrasonography of the groin was performed.

The main secondary end point was time off from work, defined as the number of days between the day of surgery and the first day a patient returned to work, for all patients who were employed. All deaths were assessed in terms of immediate cause and the relation of the death to the hernia operation. The resumption of usual activities, the score on the activities-of-daily-living questionnaire, postoperative pain, and complications were additional secondary end points.

The 5<sup>th</sup> study is related with a study of NIS, a representative sample of approximately 20% of all inpatient encounters in the USA, was queried for all ventral hernia repairs with graft or prosthesis in 2009 using ICD codes. Patients with other anterior abdominal wall hernias, such as umbilical or peristomal, or who had a resection of any portion of the digestive tract were excluded. The remaining patients were stratified into laparoscopic and open repairs. Socio-demographic data, comorbidities, complications (splenectomy, GI tract laceration, transfusion, total parenteral nutrition use, and infections) and outcomes (in-hospital death,

length of stay (LOS), and total charges) were compared between groups. The Charlson comorbidity index, a commonly used and well validated index designed to calculate mortality risk of 22 weighted comorbidities, was employed to compare comorbidities of the patients in both groups based on ICD coding.

Fifty laparoscopic and 22 open ventral hernia repairs were included in the 6<sup>th</sup> study. All patients underwent a tension-free repair with retromuscular placement of the prosthesis. No significant difference between the 2 groups was noted regarding patient demographics and hernia characteristics except that the population in the open group was relatively older (59.4 vs 47.82,  $P<0.003$ ).

In the 7<sup>th</sup> study 21 literature were reviewed in which 3480 patients underwent LVHR or OVHR (11 studies do LVHR vs. OVHR, 7 studies do only LVHR, 3 studies do only OVHR). Studies were selected from MEDLINE is searched with medical subject terms ventral hernia, mesh repair then with medical subject laparoscopy and open repair. In this study are reviewed these 21 studies and extracted the information regarding sample size, patient's characteristics, hernia size, operating time, hospital stay, complications rate and recurrence rate. Are calculated the mean operative time and length of hospital stay from each study, the recurrence rate and complications rate weighted by number of patients in each study.

## RESULTS

In the main analyses, is compared open surgery and laparoscopic surgery. Data for all patients who were randomly assigned to a treatment group and underwent surgery were analyzed. An analysis of variance for repeated measurements is performed to compare the pain score and aother parameters for the two groups. Recurrence-free survival and the time to the resumption of normal activity ( daily home activity, paid work and sports) are analyzed.

The results for the 1<sup>st</sup> study between September 2001 and May 2003, 50 laparoscopic incisional and abdominal hernia repairs were carried out in 30 patients in the department. The control group consisted of the last 50 anterior incisional hernia repairs done in the department.

Median age was 64.5 in laparoscopy group and 68 in open group. No statistical difference was noted between the 2 groups.

Median BMI was 29 in laparoscopy group and 28 in open group.



Ninety-eight percent (98%) of patients in the LG underwent their first attempt at hernia repair, while 90% of patients in the OG. One patient in the OG had the fourth repair (none with mesh), one patient a second repair (after a suture repair), and the last underwent a second repair after an initial attempt with mesh repair. The LG comprised 7 patients (14%) who had a primary abdominal hernia (6 umbilical, 1 epigastric).

No additional procedures were performed in any patients. Operative time in the LG was 59 minutes. Adhesiolysis was required in all incisional hernia repairs (43 patients). Operative time in the OG was 164.5 minutes. The difference was statistically significant. Mean hernia diameter was 10.6 cm (range, 4 to 23) in the LG and 10.5 cm (range, 7 to 21) in the OG. No drainage was used in the LG while in the OG it was used in 96% of cases. Mean length of stay was 2.1 days (range, 1 to 4) in the LG and 8.1 days (range, 6 to 14) in the OG.

In 5 (10%) LG patients, serosal tears repaired in small bowel loops because injury had occurred during dissection (3 patients) and for loops caught in previous fascial sutures (2 patients). Any of the laparoscopic procedures did not convert.

Complications occurred in 8 patients (16%) in the LG. Of these, 6 were persistent seromas (more than 4 weeks). In 1 patient, infection of the seroma occurred after 1 month, requiring removal of the mesh via laparoscopy and direct suture of the abdominal wall. Another patient had persistent neuralgia for 2 months. No gastrointestinal problems occurred related to the intraperitoneal mesh. Complications occurred in 25 patients (50%) in the OG. Twenty-three were minor complications (7 wound infections with removal mesh in 1 patient, 5 persistent serous secretions, 8 patients with persistent neuralgia, 3 small bowel occlusions), and 2 were major complications (1 pulmonary embolism, requiring admittance to the intensive care unit and 1 postoperative hemorrhage, requiring reintervention). Median follow-up was 9.0 months in the LG (range, 2 to 20) and 24.5 months (range, 14 to 43) in the OG.

#### Other Complications

Hernia recurred in 1 patient (2%) in the LG 1 month after surgery. This recurrence developed in a patient with a large hernia (20 cm) in which the mesh overlapped the defect by only 2 cm. A second laparoscopic repair was performed by placing a second mesh (10x15 cm) over the defect and obtaining a wide overlap of the hernia margins. No recurrence was observed in the OG.

Mortality was 0 in both groups.

The cost is 1,900 Euros (mesh, ultrasonic dissector, disposable trocars, and tacks) for each laparoscopic repair and 600 Euros (polypropylene mesh, no absorbable sutures, drainages, skin stapler) for each open repair. In 3 OG patients, Vicryl Knitted Mesh, costing 200 Euros, was needed to

close the peritoneum, and in 100% of cases a polypropylene mesh was used. A single day of hospitalization costs 750 Euros. In this study are calculated indirect costs multiplying per day hospitalization costs for the mean length of stay for each group and added it to obtain the total cost for each group. Total costs are lower for laparoscopic repair if the shorter length of stay is considered.

In the 2<sup>nd</sup> study are enrolled 1051 patients in the study between February 1994 and June 1995. All these patients had inguinal hernia contralateral or bilateral. During this time, 114 eligible patients were not enrolled for many reasons.

### **Perioperative and Early Postoperative Results**

The mean time from randomization to surgery was 33+36 days in the open-surgery group and 35+33 days in the laparoscopic surgery group. In the open-surgery group, a herniotomy with a high ligation of the hernial sac was performed in 21 patients (4 %). This procedure was combined with a narrowing of the internal ring with sutures in 44 (9 %), and a mesh prosthesis was inserted and a so-called tension-free repair performed in 15 (3 %).

The remaining 427 patients underwent hernioplasty, with a Bassini technique used in 147 patients (29 %), a Shouldice technique in 112 (22%), a Bassini-McVay technique in 97 (19 %), a McVay technique in 46 (9 %), and various other, less well known techniques in the other patients.

The number of operations per surgeon ranged from 1 to 33. In the laparoscopic-surgery group, the range was 1 to 74.

The median duration of surgery was five minutes shorter for the conventional repair than for the laparoscopic repair.

In the laparoscopic-surgery group, an open procedure was used in 20 patients and a transabdominal preperitoneal laparoscopic procedure was used in 4.

During laparoscopic surgery, 115 patients (24 %) had peritoneal tears, but in only 8 of these patients (7 %) did the tear result in loss of pneumoperitoneum, requiring a switch to another technique. In 15 patients (3 %), the epigastric vessels were ligated because they blocked the view of the surgeon, in 2 patients, these vessels were ligated after being injured during the insertion of a trocar.

After surgery, 64 patients had a pneumoscrotum (13 %), which disappeared within one day in all but 3 patients.

The most severe complications were serious wound in postoperative and were serious infections in six patients in the open-surgery group. Two of these patients had to be rehospitalized.

### **Postoperative Recovery**

The visual-analogue pain scores after surgery were lower in the laparoscopic-surgery group than in the open-surgery group ( $P < 0.001$ ), although the difference diminished with time. Seventeen patients in the laparoscopic-surgery group and 27 in the open-surgery group did not record pain scores. Complete data were available for 90 % of the patients. On the day of surgery, 288 patients (59 %) in the laparoscopic-surgery group did not require any analgesic drugs for postoperative pain, as compared with 165 patients (33 %) in the open-surgery group. The proportions of patients not requiring analgesia were 88 and 82 %, respectively, at one week and 92 and 91 %, respectively, at six weeks.

The patients in the laparoscopic-surgery group were able to resume normal activity sooner than the patients in the open-surgery group. Scores on the activities of daily living questionnaire which were available for 98% of the patients, were higher in the laparoscopic-surgery group at all times.

### **Complications and Recurrences**

The median follow-up was 607 days (interquartile range, 369 to 731 ). Recurrences were diagnosed in 31 patients (6%) in the open-surgery group and 17 (3%) in the laparoscopic-surgery group ( $P = 0.05$ ). There were 11 deaths in the open-surgery group and 6 in the laparoscopic-surgery group, all of which were unrelated to the hernia operation. All but 32 patients (3%) were examined in 1996.

Among the 17 patients in the laparoscopic-surgery group who had recurrences, 10 (59%) were operated on by surgeons who had just begun to perform the operation independently. Six of these 10 patients were operated on by one surgeon, and 3 of his subsequent patients had recurrences. Fourteen of the 17 recurrences (82%) in this group occurred within the first year after surgery, whereas in the open-surgery group 15 recurrences were diagnosed during the first year after surgery, and 16 during the second year. All but 12 of the 48 patients with recurrences subsequently underwent additional surgery, at which time the recurrence was confirmed.

The difference in the rates of recurrence between the two groups was similar ( $P = 0.05$ ) when the eight patients who did not undergo the assigned operation were included in the analysis.

From the results of the 3rd study:

### **Postoperative complications**

#### **1. Wound infection**

Wound-related infection was less frequent in laparoscopic repair and few of the patients required drainage and antibiotic cover in comparison with open cases.

## 2. Mesh infection

Mesh infection was very rare when compared to the open technique. Skin pathogens were responsible for most of the infections. Infections with polypropylene mesh can be managed locally but infections with ePTFE meshes need removal of the mesh.

## 3. Seroma formation

Seromas develop above the mesh and within a retained hernia sac. The mean incidence is at 4 to 8 weeks (11.4%). They rarely result in long-term problems, only aspiration may be recommended for those who enlarge or persist before they reach a large size.

## 4. Recurrence

The incidence of recurrence of ventral hernia described in the literature is decreasing depending upon treatment of infection, adequate mesh fixation, adequate overlap and diagnosing missed hernias laparoscopically.

## 5. Chronic pain

After laparoscopic repair of ventral hernia, chronic pain at suture sites is not uncommon. A possible explanation may be due to trans-abdominal sutures entrapping intercostal nerves as they course through abdominal muscles, and local ischemia of the port is another possibility. Treatment is by NSAIDs and local anesthetic injection.

## 6. Postoperative morbidity

Postoperative morbidity may be due to unrecognized enterotomy, wound infection, intraperitoneal abscess or respiratory failure. Such complications increase the duration of hospital stay and costs.

The results of the 4<sup>th</sup> study indicate that patients with inguinal hernias recover more rapidly and have fewer recurrences after laparoscopic repair than after open repair.

The duration of surgery was only slightly longer (five minutes) with laparoscopic repair, providing little support for the widespread belief that this procedure is more time-consuming than open surgery.

Nearly all the laparoscopic operations were performed with general anesthesia, whereas 60 % of the open operations were performed with spinal anesthesia. The use of general anesthesia might be considered a disadvantage of laparoscopic repair.

Nevertheless, the patients in the laparoscopic-surgery group were discharged from the hospital sooner and had less early and late postoperative pain than the patients in the open-surgery group.

The difference in the rates of recurrence in the two groups would appear to be clinically important. With prolonged follow-up, more recurrences may be expected in the open surgery group 9, and these late recurrences may be prevented only by reinforcing the groin region with additional support. A late recurrence after laparoscopic surgery may be uncommon because mesh is used routinely to reinforce the groin region from inside. The rationale for covering the defect in the abdominal wall with mesh from inside is that the repair can better withstand the pressure to which it is subjected, which originates inside the abdomen. The difference in recurrence rates in the two groups can therefore be expected to increase over time.

Early recurrences in general may be caused by technical errors. All but three recurrences in the laparoscopic-surgery group occurred within one year after surgery, and in most cases, the patients had lateral hernias that had been overlooked. Insufficient lateral preperitoneal dissection, resulting in furled mesh was another common mistake. Ten of the recurrences were in patients operated on by surgeons who had limited experience with the laparoscopic procedure, and a single surgeon was responsible for 9 of the 17 recurrences. These findings clearly illustrate the danger of underestimating the skill and experience required to master this technique.

Physical examination during follow-up is indispensable for obtaining reliable data on rates of recurrence, because follow-up by telephone or mail is unreliable. Virtually all the patients (97 %) had follow-up physical examinations performed by two experienced physicians, who made home visits to patients unable or unwilling to come to the hospital for follow-up. Although others have recognized the importance of physical examination after hernia repair, the percentages of patients examined during follow-up have usually been lower than in our study.

The patients returned to work sooner after laparoscopic repair than after open repair, as reported in several smaller trials. In the study, the difference was appreciable (a median of seven days). This difference may be explained by the absence of an inguinal incision, the absence of dissection of muscle in the groin during laparoscopic repair, and the tension-free repair, as well as by the lower complication rate.

It may be argued that a small group of surgeons who are interested in a particular procedure will always perform better than those who do not have this special interest and that different levels of experience should be taken into account when comparing our two groups of surgeons. Our surgeons were selected broadly, and the initial errors made by several of them indicate that they were not highly experienced. Within the group performing laparoscopic repairs and within the group performing conventional repairs, there were different levels of experience and skill.

The results of the 5<sup>th</sup> study. A total of 11804 cases were documented in the NIS sample after inclusion and exclusion criteria were met.

Laparoscopic repairs were performed 27.4% of the time. There were no statistically significant differences in race, gender, or mean income by zip-code.

Mean age (58.76 years in open group vs. 58.05 years,  $p=0.0087$ ) and mean Charlson score (3.54 vs 3.48,  $p<0.0001$ ) differed significantly between groups.

Open surgery was more often associated with emergent admissions (21.7% vs 15.1%,  $p<0.0001$ ).

There were significant differences comparing complications and outcomes between open and laparoscopic groups:

- complication rate (7.54% vs. 3.77%,  $p<0.0001$ ),
- average LOS (5.1 days vs. 3.5days,  $p<0.0001$ ),
- total charge (\$45700 vs \$36400,  $p<0.0001$ ) and
- mortality rate (0.88% vs 0.36%,  $p=0.0002$ ).

After controlling for confounding variables with multivariate regression, LOS and mortality rate did not significantly differ between groups. The difference in total charges remained significant ( $p=0.0032$ ), and complication rate remained significantly more likely after open surgery (OR 1.54,  $p<0.0001$ ).

The results to the 6<sup>th</sup> study are five patients were excluded from the laparoscopic group because conversion to open repair was required due to adhesions (3 patients), inability to establish pneumoperitoneum (1patient), and an ill-defined defect (1 patient).

The operative time did not significant difference between the 2 groups (laparoscopic 132.7 min vs open 152.7 min).

Conversely, patients who underwent open repair required significantly higher doses of narcotics than those in the laparoscopic group (58.95 vs 27 mg IV morphine,  $P<0.002$ ).

Similarly, the hospital stay (5.38 vs 1.88 days,  $P<0.001$ ) was significantly longer in the patient group that underwent open repair.

Analyzing the 6<sup>th</sup> study no significant difference is found in the operative time between the 2 groups (laparoscopic 132.7 min vs open 152.7 min). Laparoscopic repair was associated with a significant reduction in the postoperative narcotic requirements (27 vs 58.95 mg IV morphine,  $P<0.002$ ) and the lengths of nothing by mouth (NPO) status (10 vs 55.3 hrs,  $P<0.001$ ), and hospital stay (1.88 vs 5.38 days,  $P<0.001$ ). The incidence of major complications (1 vs 4,  $P<0.028$ ), the hernia recurrence (1 vs 4,  $P<0.028$ ), and the time required for return to work

(25.95 vs 47.8,  $P<0.036$ ) were significantly reduced in the laparoscopic group.

Obviously, a concern exists about selection bias in this study, because of the retrospective nature of the data analysis. To maintain the validity of the results of this study, certain inclusion criteria were used in patient selection. The technique used for inclusion for all ventral hernioplasties included (laparoscopic and open) resembled the tensionfree, inlay prosthetic repair described by Rives, Stoppa and Wantz. In contrast to 3 previous comparative studies, primary suture repair and onlay mesh placement were excluded from our study because they are dissimilar to the laparoscopic technique and are also associated with higher recurrence rates.

Furthermore, particular attention was given to the demographic profile and the hernia characteristics, which were relatively similar in both groups. Considering the importance of proper terminology in ventral hernias (primary, incisional, or recurrent incisional), as this reflects upon the outcome and associated morbidity of the repair, is discovered no difference in their incidence between the 2 groups. Lastly, a special effort was made to include only patients from a specific period (1994 to 2000) to achieve a similar length of follow-up for all patients. Significant differences in the length of follow-up between the 2 groups can reflect differences in the level of the surgeon's experience, choice of repair, and quality of perioperative care, which ultimately may weaken the results and not allow for a statistical comparison of recurrence rates.

Patient characteristics, such as demographics, body mass index, co morbidities, and previous attempt at hernia repair, were abstracted when available to the 7<sup>th</sup> study. However, only information on patient age and sex was consistently available in most studies.

Average patient age ranged from 46 to 60 years Other than the study by Holzman et al patient age was similar in the laparoscopic and open groups.

Similar trends were noted for patient sex, with the exception of the study by Robbins et al. last, patients undergoing laparoscopic repair were more likely to have undergone previous (failed) hernia repair in all studies in which that information was available. This difference was statistically significant in 4 of 11 studies.

The operative technique used for open repair varied across studies (Whereas 9 of 11 studies used mesh in all open repairs, some open procedures in one study involved primary repair with nonabsorbable sutures). The position of the mesh placement was either not noted explicitly or varied from onlay to inlay to underlay. Onlay was defined as placed anteriorly to the fascia, inlay was defined as sewn to the edges of

the fascial defect, and underlay was defined as placed retromuscular to the rectus sheath.

Hospital stay fourteen studies reported shorter postoperative hospital stays for patients undergoing laparoscopic repair.

Three studies reported statistically significant reductions in length of stay, 3 studies did not assess statistical significance, and the final study found a statistically nonsignificant reduction.

One study did not report data on length of stay. In pooled analysis, average length of stay was shorter in the laparoscopic group (2.0 vs. 4.0 days;  $P = .02$ ).

The study showing the largest reduction in length of stay was the only randomized controlled trial in the analysis.

Studies compared average operating room times in the 2 groups, all studies except 2 noted longer operative times (range, 17-46 minutes longer) with laparoscopic repair. The 2 remaining studies found average operating room times 24 and 29 minutes shorter with laparoscopy. In pooled analysis, is not found statistically significant difference in operative times between the laparoscopic and open groups (99 vs 96 minutes;  $P = .38$ ).

Postoperative complication:

The most common complications were wound infection, mesh infection, ileus (3%) prolonged seroma (2.6%), hernia recurrence, bowel perforations and cardiopulmonary complication .Wound infection: wound related infection in minority of cases of laparoscopic repair and few of them required drainage and antibiotic cover in comparison with open cases. Mesh infection: mesh infection were very low when compared to open, skin pathogens responsible for most of infection .Infection with polypropylene mesh can be managed locally but infection with EPTFE need removal of mesh seroma formation. It develops above the mesh and within retained hernia sac, the mean incidence at 4 to 8 weeks 11.4%. It rarely results in long term problems, only aspiration may be recommended for those enlarge or persist before they reach large size. Some article does not prefer aspiration because it may introduce infection. The patient should be well informed about this problem preoperatively the incidence of recurrence of Ventral Hernia described in these literatures is decreasing depending upon treatment of infection, adequate mesh fixation, adequate overlap, diagnosing missed hernias laparoscopically.

In a series by Olmi and colleagues, wound complications also were noted to be significantly lower in laparoscopic hernia repairs than in open repairs (1.1% versus 8.2%).



Shorter hospital stays and significantly less major morbidity have been demonstrated recently after laparoscopic ventral hernia repairs in a 10-year institutional cohort study.

Cost, however, may represent a relative disadvantage to the laparoscopic approach. Operating room supply costs can be significantly greater with laparoscopic than with open repairs (\$2237 versus \$664). The operative time was significantly longer as well (149 versus 89 minutes). These figures probably reflect the positioning, port placement, and specialized equipment needed to perform a laparoscopic hernia repair. Overall hospital costs for these patients, however, were slightly lower, reflecting the shorter length of stay of the laparoscopic patient ( 0.2 days versus 0.6 days).

# TABLES

TABLE 1

**Table 3.**

Patient Demographics

	Lap	Open	P
<b>No. of patients</b>	50	22	
<b>Age (yrs)</b>	47.8	59.4	<0.003
<b>Sex (M/F)</b>	17/33	8/14	NS
<b>BMI (Kg/m<sup>2</sup>)*</b>	32.62	33.65	NS
<b>Patients with comorbid factors</b>	29	17	NS

\*BMI=Body mass index.

TABLE 2

**Table 4.**

Hernia Characteristics

	Lap	Open	P
<b>Size (cm<sup>2</sup>)</b>	124.6	201.6	NS
<b>Location</b>			
Midline	40	17	NS
Lateral	10	5	
<b>Type</b>			
IVH*	42	21	NS
PVH†	8	1	
<b>No. of previous repairs per patient</b>	1.3	1.3	NS

\*IVH=Incisional ventral hernia.

†PVH=Primary ventral hernia.

**TABLE 3: Results of 3<sup>rd</sup> study**

	Laparoscopic repair	Open repair
<b>No. of patients</b>	<b>25</b>	<b>25</b>
<b>Types of hernia</b>		
1) incisional	14	20
2) umbilical	06	04
3) paraumbilical	02	01
4) epigastric	03	00
<b>Duration of operation (min.)</b>	<b>100</b>	<b>120</b>
<b>Postop. hospital stay (days)</b>	<b>03</b>	<b>07</b>
<b>Analgesic requirement (days)</b>	<b>03</b>	<b>07</b>
<b>Antibiotic requirement (days)</b>	<b>02</b>	<b>07</b>
<b>Postop. NBM (days)</b>	<b>01</b>	<b>03</b>
<b>Complications</b>		
1) bleeding	02	05
2) bowel injury	00	02
3) wound infection	01	04
4) recurrence	00	01
<b>Return to normal activities (days)</b>	<b>08</b>	<b>20</b>

**TABLE 4: Comparison of many studies**

Observation	Holzman <sup>4</sup>		Park <sup>10</sup>		Carbajo <sup>7</sup>		Ramshaw <sup>11</sup>	
	Lap/Open		Lap./Open		Lap./Open		Lap./Open	
Operating time (min.)	128	98	95	78	87	112	58	82
Length of stay (days)	1.6	05	3.4	6.5	2.2	9.1	1.7	2.8
Postop. complication rate (%)	23	31	18	37	20	50	15	26
Infection rate (%)	05	06	00	02	00	18	00	03
Seroma rate (%)	05	00	04	02	13	67	00	00
Follow-up (months)	10	19	24	54	27	27	21	21
Recurrence (%)	10	13	11	35	00	07	03	21
Patients	20	16	56	49	30	30	79	174

**Table 5.**

Postoperative Results

	Lap Open		P
<b>Operative time (min)</b>	132.7	152.7	NS
<b>Pain control (mg iv morphine)</b>	27	58.95	<0.002
<b>Length of NPO status (hrs)*</b>	10	55.38	<0.001
<b>Length of hospital stay (days)</b>	1.88	5.38	<0.001

\*NPO=nothing by mouth.

**TABLE 6: Results of 5<sup>th</sup> study**

	OPEN GROUP	LAPAROSCOPY GROUP
AGE	58.76 years	58.05 years
CHARLSON SCORE	3.54	3.48
EMERGENT ADMISSION	21.7%	15.1%
COMPLICATION RATE	7.54%	3.77%
AVERAGE LOS	5.1 days	3.5 days
TOTAL CHARGE	45700\$	3640\$
MORTALITY RATE	0.88%	0.36%

**TABLE 7: Results of 6<sup>th</sup> study**

	LAPAROSCOPY GROUP	OPEN GROUP
OPERATIVE TIME	132.7 min	152.7 min
DOSE OF NARCOTICS	27 mg i.v.	58.95 mg i.v.
NOTHING BY MOUTH (NPO) STATUS	10 hours	55.3 hours
HOSPITAL STAY	1.88 days	5.38 days
MAJOR COMPLICATIONS	1	4
TIME FOR RETURN TO WORK	25.95 days	47.5 days

# DISCUSSION

A number of patient factors are thought to predispose to hernia formation. These factors include a personal history of aneurysms, morbid obesity, the size of the defect, and, in the case of recurrent hernias, the technique used in the initial repair. Other patient-oriented factors that are relevant for both laparoscopic and open approaches include diseases of abnormal collagen synthesis, such as Marfan's syndrome, Ehlers-Danlos syndrome, and osteogenesis imperfecta. Each of these conditions is correlated with an increased incidence of hernia formation. Also of interest as a factor are decreased collagen I/III ratios or varied expression profiles of matrix metal. Compelling evidence suggests that the larger the initial hernia defect, the greater is the chance for recurrence after repair. Above an approximately 4-cm threshold, the risk of recurrence has been demonstrated to be threefold higher in patients undergoing a nonmesh primary tissue repair. Consequently, primary repair typically is reserved for small ventral or umbilical hernias. Because the long-term recurrence rate of small incisional hernias repaired by primary closure is approximately 50%, fewer surgeons currently attempt such repairs.

The risk of recurrence is determined by surgical-technical factors (i.e. mesh use, choice and placement), the experience of the surgeon, the occurrence of a wound infection and patient related factors. The recurrence rates are low in experienced hands. Smoking, diabetes, coronary artery disease, chronic obstructive pulmonary disease (COPD), nutritional status, immunosuppression, chronic corticosteroid use, low serum albumin, obesity and advanced age increase the risk of recurrence rate. A prolonged operative time and the use of an absorbable synthetic mesh are also significant independent predictors of wound infection and associated recurrences.

Laparoscopic ventral hernia repair was started by LE BLANC in 1993. After that, evaluations were done to make laparoscopic surgery easier and safer for ventral hernia repair.

The results of non-randomized controlled study revealed that, as compared to open repair, laparoscopic repair is associated with lesser time for surgery, reduced post-operative pain, analgesic requirement and antibiotic requirement, shorter hospital stay and earlier return to normal daily activities. The complication rate for laparoscopic repair was low. The laparoscopic procedure was associated with potentially less wound infection compared with open repair.

The excellent results of the studies are quite comparable with other studies, which supports that laparoscopic ventral hernia repair should be the procedure of choice in an experienced laparoscopic surgeon's hand.

Patients with inguinal hernias recover more rapidly and have fewer recurrences after laparoscopic repair than after open repair.

The duration of surgery was only slightly longer (five minutes) with laparoscopic repair, providing little support for the widespread belief that this procedure is more time-consuming than open surgery.

Nearly all the laparoscopic operations were performed with general anesthesia, whereas 60 % of the open operations were performed with spinal anesthesia. The use of general anesthesia might be considered a disadvantage of laparoscopic repair.

Nevertheless, the patients in the laparoscopic-surgery group were discharged from the hospital sooner and had less early and late postoperative pain than the patients in the open-surgery group.

The difference in the rates of recurrence in the two groups would appear to be clinically important. With prolonged follow-up, more recurrences may be expected in the open surgery group, and these late recurrences may be prevented only by reinforcing the groin region with additional support. A late recurrence after laparoscopic surgery may be uncommon because mesh is used routinely to reinforce the groin region from inside. The rationale for covering the defect in the abdominal wall with mesh from inside is that the repair can better withstand the pressure to which it is subjected, which originates inside the abdomen. The difference in recurrence rates in the two groups can therefore be expected to increase over time.

Early recurrences in general may be caused by technical errors. All but three recurrences in the laparoscopic-surgery group occurred within one year after surgery, and in most cases, the patients had lateral hernias that had been overlooked. Insufficient lateral preperitoneal dissection, resulting in furled mesh was another common mistake. Ten of the recurrences were in patients operated on by surgeons who had limited experience with the laparoscopic procedure, and a single surgeon was responsible for 9 of the 17 recurrences. These findings clearly illustrate the danger of underestimating the skill and experience required to master this technique.

Physical examination during follow-up is indispensable for obtaining reliable data on rates of recurrence, because follow-up by telephone or mail is unreliable. Virtually all the patients (97 %) had follow-up physical examinations performed by two experienced physicians, who made home visits to patients unable or unwilling to come to the hospital for follow-up. The patients returned to work sooner after laparoscopic repair than after open repair, as reported in several smaller trials. In the study, the

difference was appreciable (a median of seven days). This difference may be explained by the absence of an inguinal incision, the absence of dissection of muscle in the groin during laparoscopic repair, and the tension-free repair, as well as by the lower complication rate.

It may be argued that a small group of surgeons who are interested in a particular procedure will always perform better than those who do not have this special interest and that different levels of experience should be taken into account when comparing the two groups of surgeons. The surgeons were selected broadly, and the initial errors made by several of them indicate that they were not highly experienced. Within the group performing laparoscopic repairs and within the group performing conventional repairs, there were different levels of experience and skill.

Nevertheless, the study confirms previous reports demonstrating that laparoscopic ventral hernia repair significantly shortens hospital stay. On the other hand, it is found that the laparoscopic approach does not prolong operative time. Although, in the study the overall complication rate was not different between the 2 groups, interestingly is observed a significant decrease in the incidence of major postoperative complications. The study is also the first to produce statistically supporting evidence for an existing significant difference in the recurrence rate in favor of the laparoscopic group.

A prospectively randomized study comparing the open and the laparoscopic repair of ventral hernias is that by Carbajo's group. Carbajo et al demonstrated that the laparoscopic approach decreases the incidence of complications and hernia recurrence. However, other parameters, such as postoperative pain control and length of recovery, were not evaluated in his trial. The 7<sup>th</sup> study is the first to validate the presumption that the laparoscopic approach does indeed significantly improve the patient's postoperative comfort and allows faster recovery. Furthermore, laparoscopic repair is associated with earlier return to work and regular activities. Without a doubt, this observation is expected to positively affect the burden on financial and human resources that results from temporary disability, including days off from work, after ventral hernia repair.

Clearly, laparoscopic ventral hernioplasty offers significant advantages over the open approach. It provides better visualization of the hernia defect, leading to a more adequate repair, which probably explains the associated lower recurrence rate. The faster recovery time, the markedly improved postoperative patient comfort and the reduced complication rate observed with the laparoscopic approach will entirely change the concept of the "frustrating problem" and the significant morbidity that surgeons often encounter with ventral hernia repair.



Laparoscopic repair has the potential benefits of smaller wounds, with less wound infections and better cosmetic results, and the possibility to perform the procedure in the outpatient clinic. Patients are thought to experience less postoperative discomfort and a faster recovery time. Additional benefit, especially in incisional hernia surgery, is the possibility to diagnose and treat multiple hernias in one procedure. During laparoscopic repair a mesh is placed intraperitoneally which makes contact between the mesh and viscera inevitable. The contact with the viscera can lead to adhesion formation and associated complications like small bowel obstruction, enterocutaneous fistula, infertility and chronic pain. Other possible complications of the laparoscopic approach in general are bowel and bladder injuries, artery laceration, neuralgia and trocar site herniation. During laparoscopic hernia repair it is hardly ever possible to restore functional anatomy of the abdominal wall and manage skin redundancy or the hernia sac.

Unfortunately collagen meshes cannot be introduced through a laparoscopy port yet and more research on outcome and recurrence rates should be done. Finally until now surgeons and hospitals are also reluctant as costs of biological meshes are very high compared to synthetic meshes.

The laparoscopic approach offers several key advantages over the open approach, including low risks of infection and shortened hospital stay in addition to reductions in complication rates, postoperative pain, and postoperative ileus. The lower recurrence rates reported with laparoscopy are convincing, although they remain to be demonstrated conclusively. Even lowered overall hospital costs have been associated with laparoscopic hernia repair.

Another advantage of the laparoscopic approach is the ability to address an enterotomy without needing to convert to an open procedure with return to the operating theater at a later date to perform a definitive laparoscopic hernia repair with prosthetic material.

The use of mesh is the reason for the reduced recurrence associated with incisional hernia repairs.

Another demonstrated laparoscopic advantage is the ability to evaluate the abdominal wall fully with substantially improved visualization. Laparoscopic adhesiolysis allows the abdominal wall to be inspected in a more thorough way, permitting identification of remote or “Swiss-cheese” defects that might have been missed with the less optimal visualization of the open approach.

#### Disadvantages

Seromas are one of the most common postoperative findings in both laparoscopic and open incisional hernia repairs. In large open hernia repairs, the resultant dead space beneath the skin flaps often is treated

prophylactically by the placement of closed suction drains so that the resultant seroma is aspirated as it forms. In laparoscopy, because drains are not routinely placed, seromas are seen more often.

Consideration must be given to the use of carbon dioxide as the insufflation agent during laparoscopy. The additional carbon dioxide burden is a contraindication to laparoscopic herniorrhaphy for patients who have severe chronic obstructive pulmonary disease. Because even a relatively modest increase in afterload or decrease in preload would prove problematic, patients who have extremely poor cardiac reserve may be better served by an open approach or watchful waiting.

Accessing the abdomen for a laparoscopic hernia repair and performing adhesiolysis does carry a potential risk of injury to intestine, which, if missed, can lead to intra-abdominal sepsis. Itani and colleagues have reported the rates of bowel injury as 7.2% in open hernia repairs and 9% in laparoscopic procedures. Others have reported that the incidence of bowel injuries differs insignificantly between laparoscopic and open approaches and is low in both approaches. The bowel actually is easier to identify in laparoscopic surgery than in open surgery, because it generally hangs down, away from the abdominal wall, and insufflation permits better plane definition. Additionally, intestinal injuries may not be reported as consistently in the open literature as in laparoscopic papers. It is possible that these injuries occur in much higher percentages in traditional open surgery, but, because they do not require a change in procedure, they may be underrecognized. In any case, prompt recognition of these injuries is critical to avoid late complications. These injuries can be obvious (eg, traction or sharp dissection injuries) or can be subtle (eg, a delayed thermal injury). Careful attention to tissue handling and thorough inspection of the intestine using meticulous completion laparoscopy to assess for intestinal injuries can minimize these risks.

Bleeding from abdominal wall vessels is another complication that rarely occurs in an open approach but can cause frank hemorrhage or significant hematoma if not recognized. At times, a trocar can stem the bleeding temporarily, but the bleeding may resume in the early postoperative period.

The presence of sutures, therefore, contributes substantially to the repair. Persistent pain at these suture sites is a problem unique to the laparoscopic approach and occurs in 1% to 3% of patients. This discomfort may be caused by the sutures entrapping an intercostal nerve, or the suture itself may compress muscle significantly enough to cause persistent pain. This discomfort is often self limited, but conservative measures such as the use of nonsteroidal anti-inflammatory drugs or local injection of steroid or anesthetic may provide symptomatic relief in the interim.

Wound complications are reduced significantly in laparoscopic ventral hernia repairs when compared with open repairs. In many cases, a wound or mesh infection following an open repair with prosthetic materials other than ePTFE can be managed nonoperatively with local wound-care interventions.

There has been substantial literature generated on the topic of incisional hernia repair and the laparoscopic and open approaches. Each has advantages and disadvantages. The collective results of all of these studies suggest that laparoscopic ventral hernia repairs have reduced perioperative morbidity, fewer wound complications, and lower rates of hernia recurrence. These benefits suggest that for many patients laparoscopy is an appropriate approach for the repair of incisional hernias in both straightforward and complex presentations. There is still a role for the traditional open approach, primarily in patients who have a specific contraindication to a minimally invasive approach or in whom additional procedures are planned.

Finally as a summary are presented in a list the advantages and disadvantages of the laparoscopic and open approach.

- A laparoscopic repair requires several small incisions instead of a single larger cut.
- Mostly, patients must receive general anesthesia for laparoscopic repair, while open hernia repair can be done under general, spinal or local anesthesia.
- If hernias are on both sides (in inguinal hernia), they can be repaired at the same time without the need for a second large incision. Laparoscopic surgery allows the surgeon to examine both groin areas and all sites of hernias for defects. In addition, the patch or mesh can be placed over all possible areas of weakness, helping prevent a hernia from recurring in the same spot or developing in a different spot.
- The defect in the abdominal wall is repaired from the inside of the abdominal cavity and instead of closing or patching the repair from the outside, the patch is secured in place from the inside. This eliminates the necessity of cutting the skin and normal tissues of the groin to get down to and repair the hernia.

In addition to these differences, there are several advantages of laparoscopic hernia repair over an open operation as follows:

- Less post-operative pain.
- Smaller incisions and faster recovery.
- Less blood loss.

- No further incisions required for patients with hernias in both groins (bilateral hernia).
- Ideal method for patients with recurrent hernias after previous surgery.
- Early discharge from hospital. Either same day or next day after surgery.
- Very early return to work, often within 3 days for sedentary workers and around 1 to 2 weeks for manual workers.
- Because smaller incisions are used, laparoscopy may be more appealing for cosmetic reasons.
- The greater availability of space by the extraperitoneal approach facilitates the insertion of a much bigger mesh as compared to a smaller mesh when performing an open repair.
- In recurrent hernia, the dissection proceeds through a virgin area which was not previously operated upon, thus reducing the chances of nerve and vascular injury.

On the other hand, there are disadvantages for laparoscopic repair over open operation as follows:

- More costly depending on level of health cover.
- Takes longer time to be performed.
- May not be suitable for patients with very large hernias or previous lower abdominal surgery.

Moreover, laparoscopic surgery repair may not be appropriate for people who:

- Have an incarcerated hernia.
- Can't tolerate general anesthesia.
- Have had many abdominal surgeries. Scar tissue may make the surgery harder to do through the laparoscope.
- Have severe lung diseases such as emphysema. The carbon dioxide used to inflate the abdomen may interfere with their breathing.
- Are pregnant.
- Are extremely obese.

Laparoscopic hernia repair is not usually done on children, but a laparoscope may be used during open hernia repairs in children to explore the opposite groin for a hernia. This can be done by inserting the laparoscope into the side that is being operated on.

Another difference between laparoscopic and open surgery is complications.

## Major Complications for Open Repair

- Hemorrhage
- Testicular Atrophy
- Vas Deferens Transaction
- Bowel Injury
- Bladder injury
- Minor Complications for Open Repair
- Scrotal Ecchymosis
- Wound Infection
- Urinary Retention
- Recurrence
- Hydrocele
- Nerve Transaction
- Nerve Entrapment

## Major Complications for Laparoscopic Repair

- Hemorrhage
- Bowel Injury
- Bladder Injury
- Major Vessel Injury
- Minor Complications for Laparoscopic Repair
- Urinary Retention
- Trocar Site Hernia
- Nerve Injury
- Wound Infection
- Small Bowel Obstruction

# CONCLUSION-PROPOSALS

For conclusion this review is presenting the parameters for choosing the better approach between the laparoscopic and open surgery of the anterior abdominal wall hernias.

In Nowadays laparoscopic repair of anterior abdominal wall hernias is being accepted by most of surgeons and patients. The laparoscopic have advantages versus the open. Many of them are the less post-operative pain, shorter hospital stay, less wound infection, less recurrence, reduced complication rate. Almost all ventral hernias can be repaired by laparoscopy, regardless of morbid obesity and age group. Even possible

to reduce operative time because of standardized techniques, surgeons getting more skill, use of mesh fixation devices, new mesh implantation. The disadvantages of the laparoscopy are the greater anesthesia that is needed. General anesthesia is usually necessary. In comparison with the open repair under local anesthesia the laparoscopy is cost-effective. High risk of bowel injury, the long time learning curve for the surgeons and the uncertain long-term effectiveness of the laparoscopic technique call for more and larger studies with adequate follow-up before definitive conclusions on the true value of this procedure can be derived.

Smaller incisional hernias with a transverse diameter < 10 cm can be repaired successfully by a laparoscopic approach if a suitably skilled surgeon is available, although an ugly scar may remain on the anterior abdominal wall. Major defects > 10 cm are best repaired by an open operation. The simplest and most versatile technique is the onlay method. Hernias with loss of domain can only be repaired by an open method supplemented by components' separation.

The best for the system of health care is to succeed the best skill for the surgeons in a specialized centre. It is combined with a good equipment of the surgical clinics for the laparoscopic procedure. Follow the appropriate procedure for the patient basis on the criteria.

Laparoscopic repair of anterior abdominal wall hernias is considered as first choice versus open regardless minimal access and procedures. However, there is no “best” form of hernia repair; it is to be tailored according to the nature of hernia, patient characteristic and the preference of the surgeon and the patient.

## **ABSTRACT**

### **Introduction**

Hernias of the anterior abdominal wall are very common surgical problems. Laparoscopic and open techniques are used to repair them. Laparoscopic techniques have become more common in recent years. A lot of studies try to find the best method.

### **Objective**

In this review is made an analysis of studies which make a comparison of laparoscopic and open repair of anterior abdominal wall hernias.

### **Material**

The results of seven studies with the same subject are compared.

### **Methods**

Electronic databases such as Google scholar, Springer link, Pub med and other references were searched.

### **Selection criteria**

Randomised controlled studies were selected, which compared the two techniques in patients with ventral, incisional, inguinal hernias and any other hernia of the anterior abdominal wall. The sample of patients has common characteristics.

### **Results**

All the studies are analyzed. In many situations are extracted different results. The review includes 7 studies. In these studies are included only hernias of the anterior abdominal wall. The recurrence rate is reduced in the laparoscopic procedure. In all the studies the patients were followed-up. Results on operative time are different in the studies. The hospitalization was shorter and the return to work was earlier in all the studies for the laparoscopic technique. The risk of intraoperative complications was slightly higher in laparoscopic repair in all the studies. The most clear and consistent result was that laparoscopic technique reduced the risk of wound infection. The control of postoperative pain intensity seems to be better in the laparoscopic procedure. Open repair has better result to the cost-effectiveness without including the cost of hospital stay.

### **Discussion**

A number of patient factors are thought to predispose to hernia formation. The risk of recurrence is determined by surgical-technical factors. Recurrence rate is low in experienced hands. The results after the compare of the two procedures for the patients are better for the laparoscopic technique. The cost of the surgery and the co-morbidity are disadvantages for the laparoscopic approach.

### **Conclusion**

Laparoscopic and open procedure of the anterior abdominal wall hernias are safe techniques. The best procedure is related to the nature of hernia, patient characteristic and the preference of the surgeon and the patient.

# ΠΕΡΙΛΗΨΗ

## Εισαγωγή

Οι κήλες του πρόσθιου κοιλιακού τοιχώματος είναι πολύ συνηθισμένες χειρουργικές παθήσεις. Η λαπαροσκοπική και η ανοικτή τεχνική χρησιμοποιούνται για να αποκαταστήσουν τις κήλες. Η λαπαροσκοπική συνηθίζεται τα τελευταία χρόνια. Πολλές μελέτες προσπαθούν να βρουν την καλύτερη μέθοδο.

## Σκοπός

Σ' αυτήν την ανασκόπηση πραγματοποιείται ανάλυση μελετών που συγκρίνουν την ανοικτή με την λαπαροσκοπική αποκατάσταση κηλών του πρόσθιου κοιλιακού τοιχώματος.

## Υλικό

Τα αποτελέσματα εφτά μελετών με το ίδιο θέμα συγκρίνονται.

## Μέθοδος

Αναζητήθηκαν πληροφορίες στη μηχανή αναζήτησης του Google scholar, στο Springer ling, στο Pub med, καθώς και σε σχετιζόμενες αναφορές από την αναζήτηση της βιβλιογραφίας

## Κριτήρια επιλογής

Επιλέχθηκαν τυχαιοποιημένες ελεγχόμενες μελέτες οι οποίες σύγκριναν τις δύο τεχνικές σε ασθενείς με κοιλιοκήλη, μετεγχειρητική κήλη, βουβωνοκήλη και κάθε κήλη του πρόσθιου κοιλιακού τοιχώματος. Το δείγμα των ασθενών έχει κοινά χαρακτηριστικά.

## Αποτελέσματα

Όλες οι έρευνες που αναλύθηκαν, σε μερικές περιπτώσεις ανέδειξαν διαφορετικά αποτελέσματα. Η ανασκόπηση περιλαμβάνει εφτά μελέτες. Σε αυτές τις μελέτες περιλαμβάνονται μόνο κήλες στο πρόσθιο κοιλιακό τοίχωμα. Η συχνότητα υποτροπής μειώνεται στη λαπαροσκοπική διαδικασία. Σε όλες τις μελέτες υπήρξε παρακολούθηση των ασθενών. Τα αποτελέσματα όσον αφορά τη διάρκεια της χειρουργικής επέμβασης διαφέρουν. Η παραμονή στο νοσοκομείο ήταν μικρότερη και η επιστροφή γρηγορότερη για τη λαπαροσκοπική χειρουργική σε όλες τις μελέτες. Ο κίνδυνος διεγχειρητικών επιπλοκών ήταν μεγαλύτερος στην λαπαροσκοπική χειρουργική σε όλες τις έρευνες. Το πιο ξεκάθαρο και σίγουρο ήταν ότι η λαπαροσκοπική μείωσε τον κίνδυνο της επιμόλυνσης του τραύματος. Ο έλεγχος του μετεγχειρητικού άλγους φαίνεται να είναι καλύτερος στη λαπαροσκοπική αποκατάσταση. Η ανοικτή αποκατάσταση έχει καλύτερα αποτελέσματα όσον αφορά το κόστος, χωρίς όμως να περιλαμβάνεται η παραμονή στο νοσοκομείο.



## Συζήτηση

Ένας αριθμός παραγόντων που σχετίζονται με τους ασθενείς καθορίζουν το σχηματισμό της κήλης. Η πιθανότητα υποτροπής καθορίζεται από παράγοντες χειρουργικής τεχνικής. Η συχνότητα υποτροπής μειώνεται σε έμπειρα χέρια. Η σύγκριση των δύο τεχνικών έχει καλύτερα αποτελέσματα για τους ασθενείς με τη λαπαροσκοπική χειρουργική. Το κόστος της χειρουργικής επέμβασης και η συνοσηρότητα είναι μειονεκτήματα για τη λαπαροσκοπική παρέμβαση.

## Επίλογος

Η λαπαροσκοπική και η ανοικτή αποκατάσταση κηλών του πρόσθιου κοιλιακού τοιχώματος είναι ασφαλείς τεχνικές. Η καλύτερη διαδικασία εξαρτάται από το είδος της κήλης, τα χαρακτηριστικά του ασθενούς και την προτίμηση του χειρουργού και του ασθενούς.

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