

# INGUINAL HERNIA: CLASSIFICATION, DIAGNOSIS AND TREATMENT CLASSIC, TRAUMATIC AND SPORTSMAN'S HERNIA

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*Abstract:* Inguinal hernia repair is performed in more than 600,000 cases every year in the United States. However, the true prevalence may be even higher. Many groin hernias are not diagnosed, e.g., Sportsmans' hernia, or are asymptomatic. The etiology of classic inguinal hernia, Sportsman's hernia or traumatic hernia may be different. The hernia repair is performed in agreement with a classification of the hernia, e.g., Nyhus classification. According to recent randomized controlled trials and meta-analyses open-mesh repair demonstrates several advantages in comparison to laparoscopic procedures.

Laparoscopic procedures require more time and cost more, show a potential for serious complications and may be followed by an increased rate of recurrence. There may be a faster reconvalescence after laparoscopic procedures. However, there may be also a selection bias. Laparoscopic procedures are associated with specific complications, e.g., pneumomediastinum, pneumothorax, gas extravasation, trocar injuries, intra-abdominal adhesions, bowel obstruction, which are rarely or never seen in open-mesh repair.

In the United States we could observe an uncoupling of hernia repair from classification. In more than 90% of cases the treatment was open-mesh. In many hernia studies the hernias were classified as direct or indirect, primary or recurrent. The existing classifications are based on anatomical findings in relation to the development of the hernia: posterior floor integrity, enlarged interior ring and size of the hernia. However, the size of the hernia may not always be associated with the severity of the hernia and it may be difficult to estimate. The outcome of hernia repair may be influenced by other factors. There may be differences in the presentation of the hernia to the surgeon based on the damage done to the surrounding tissue in the inguinal canal, e.g., external ring, aponeurosis of the external oblique, inguinal ligament, which is most often accompanied by severe adhesions. Further factors influencing outcome of hernia repair may be patient-related factors, e.g., constipation, ASA classification, diabetes, smoking. A classification should be simple to use and easy to remember: (A) indirect hernia, (B) direct hernia, (C) scrotal or giant hernia, (D) femoral hernia. A and B can be classified as (0) uncomplicated, (1) posterior floor defect, (2) posterior floor defect plus defect in the anterior part of the inguinal canal. All four types (A-D) may be either primary or recurrent. In this classification combined femoral, indirect

and/or direct hernias can be categorized by using the types A, B, C, or D as in a modular construction system. The category "other" is reserved for rare types of hernia, e.g., obturator hernia, Spiegheilian hernia. Aggravating factors are included: Diabetes, obesity, age above 65, constipation, ASA III or more and cigarette smoking. This classification may be helpful to evaluate outcome of hernia repair with regard to patient related factors and the increased demands for the surgeon and the staff.

In some health care systems the general belief is that all hernias are equal and be managed equally. However, groin hernias may be complex and need individual treatment.

*Key words:* Hernia repair, open-mesh repair, laparoscopic hernia repair

## INTRODUCTION

There are more than 600,000 hernia repairs every year in the United States (Malangoni and Gagliardi 2004). Inguinal hernia repair may be performed as anterior-open-suture (Shouldice 1953; Shouldice 2003) or anterior-open-mesh (Lichtenstein et al. 1989; Rutkow and Robbins 1993), posterior-open (Nyhus 1993) or laparoscopic as transabdominal preperitoneal repair (TAPP) or as total extraperitoneal repair (TEP) (Davis and Arregui 2003). Several hernia classification systems, which were related to the pathogenesis of hernia, have been developed to support the surgeon in the hernia repair and to alleviate a comparison between the different techniques of hernia repair. In 1989, Gilbert published a classification system based on anatomic and functional aspects according to intra-operative findings, like presence or absence of the peritoneal sac, the size of the internal ring, and the status of the posterior wall (Gilbert 1989). In 1991, the Nyhus classification emphasizes the anatomic criteria including the size of the internal ring and status of the posterior wall (Nyhus 1991). Yet, the classifications are known to be incomplete (Malangoni and Gagliardi 2004) or do not reflect the recent developments in hernia repair (Rutkow and Robbins 1998). Sportsman's hernia (Malycha and Lovell 1992) and traumatic hernia (Catalano and Perez 1962; Dimyan et al. 1980; Guly and Stewart 1983) are separate entities of inguinal hernias. Traumatic and sportsman's hernia are rarely reported (Ganchi and Orgill 1996). The number of re-

ports may not represent the real prevalence. Groin disruption can be misdiagnosed as strains or some type of sportsman's hernia for which conservative treatment may suffice (Hackney 1993). Groin injuries comprise two to five percent of all sport injuries, in soccer players five to seven percent, but concomitant diseases may be present and may cause difficulties to diagnose the hernia in patients practising sport (Renstrom and Peterson 1980; Karlsson et al. 1994; Westlin 1997). There is no doubt that there is a growing rate of accidents in sports, e.g., soccer, (Young 2002) and surgeons are confronted with an increased rate of these types of hernia. In 1998, Rutkow and Robbins criticized, that the existing hernia classifications do no longer fulfil their purpose to direct the surgeon's decision for a type of hernia repair. Indeed, surgical procedures for hernia repair have changed during the last

years. Nowadays in the United States more than 90% of inguinal hernias are repaired by open-mesh (Rutkow 2003). The existing hernia classifications are based on general anatomic descriptions (direct, indirect, posterior wall, inguinal ring) and less on other basic intra-operative findings, e.g., adhesions or nerve entrapment, which may demand special surgical practice. Other types of hernia, e.g., sportsman's hernia, traumatic hernia may be different with regard to pathogenesis, differential diagnosis, intra-operative findings and prognosis. These factors may have an impact on the risk of complications, surgical dissection, and outcome. Inguinal hernia, including sportsman's hernia and traumatic hernias, are reviewed with regard to definition, epidemiology, pathogenesis, differential diagnosis, diagnosis, and treatment. My proposal for a new classification (Tables 1 and 2) is discussed.

*Table 1.* Classification of inguinal hernia, based on intra-operative findings by Holzheimer (2005) The combined hernia, direct and indirect hernia, is included in this classification by the combination AB.

Type of hernia	Intraoperative findings	Status
<b>A Indirect hernia</b>	0 uncomplicated 1 posterior floor defect 2 posterior and anterior defect	I primary II recurrent
<b>B Direct hernia</b>	0 uncomplicated 1 posterior floor defect 2 posterior and anterior defect	I primary II recurrent
<b>C Scrotal or giant hernia</b>		I primary II recurrent
<b>D Femoral hernia</b>		I primary II recurrent
<b>O Others (rare hernias e.g., obturator hernia, Spieghehlian hernias)</b>		

*Table 2.* Proposal of a classification of inguinal hernia which may be used for severity grading: combined (direct and indirect) hernia is included in this classification by the combination AB.

Type of hernia	Intra+operative findings	Status
<b>A Indirect hernia</b>	0 uncomplicated 1 posterior floor defect 2 posterior and anterior defect	2 4 6 I primary x1 II recurrent x2
<b>B Direct hernia</b>	0 uncomplicated 1 posterior floor defect 2 posterior and anterior defect	2 4 6 I primary x1 II recurrent x2
<b>C Scrotal or giant hernia</b>		6 I primary x1 II recurrent x2
<b>D Femoral hernia</b>		6 I primary x1 II recurrent x2

Aggravating factors:

Diabetes	1
Obesity	1
Age > 70	1
Constipation	1
ASA $\geq$ III	1
Smoking	1
Previous operation in the lower abdomen	1
Steroid use	1

## EPIDEMIOLOGY

### INGUINAL HERNIA

There are more than 600,000 hernia repairs every year in the United States. 5% of the population will develop an abdominal hernia; the prevalence, however, may even be higher (Malangoni and Gagliardi 2004).

### TRAUMATIC HERNIA

Until recently there were only few reports on traumatic hernia and most of them were related to blunt abdominal trauma (Metzdorff et al. 1984; Otero and Fallon 1988; Ganchi and Orgill 1996; Vasquez et al. 1999).

### SPORTSMAN'S HERNIA

Groin injuries comprise 2 to 5 percent of all sport injuries (Renstrom and Peterson 1988; Karlsson et al. 1994), in soccer players 5 to 7 percent of all injuries occur in the groin (Westlin 1997). There is a growing evidence to support the notion that inguinal canal disruption may occur without clinically and sonographically detectable hernia, especially in cases resistant to conservative treatment (Malycha and Lovell 1992; Hackney 1993; Simonet et al. 1995). The prevalence of sportsman's hernia among athletes with chronic groin pain has been reported to be as high as 50% (Lovell 1995). Sports and extreme sports, designed to expose athletes to greater challenges and risks, are growing in popularity (Young 2002). Indoor soccer may be accompanied by increased risk for injuries (Hoff 1986; Lindenfeld et al. 1994; Putukian et al. 1996).

## DEFINITION

Classic inguinal hernia, sportsman's hernia and traumatic hernia are different in many aspects.

### INGUINAL HERNIA

Inguinal hernia has been defined as a bulge of the peritoneum through a congenital or acquired defect in the muscular and fascial structures of the abdominal wall (Conze et al. 2001).

### TRAUMATIC HERNIA

Traumatic hernia has been described as a herniation through disrupted abdominal wall musculature and fascia, associated with recent trauma, without skin penetration and without evidence of a previous hernia defect (Damschen et al. 1994).

### SPORTSMAN'S HERNIA

In 1992 Gilmore characterised the disruption to the inguinal canal, without recent trauma, by three intra-operative findings: (1) a torn external oblique aponeurosis causing dilatation of the superficial inguinal ring, (2) a torn conjoint tendon, and (3) a dehiscence between the torn conjoint tendon and the inguinal ligament, constituting the major injury. These disruptions

were then termed "sports hernia", "sportsman's hernia", "conjoint tendon lesion", "athletic pubalgia" or "crypt hernia" (Kumar et al. 2002).

## PATHOGENESIS

### INGUINAL HERNIA

The development of an inguinal hernia is multifactorial. In case of a congenital pathogenesis a preformed opening is caused by incomplete closure of the abdominal wall or in case of acquired hernia it is caused by a dehiscence of the fascias accompanied by a loss of abdominal wall strength. Etiologic factors may be increased intra-abdominal pressure or changes in the connective tissue (Conze et al. 2001).

### TRAUMATIC HERNIA

Traumatic hernia involves sudden application of a blunt or shearing force to the abdominal wall over an area large enough to prevent penetration of the skin (Al-Quasabi and Tandon 1988). Multiple mechanisms have been described including motor vehicle accidents, bicycle handlebar and seat belt injuries, as well as autopenetrating injuries (Dimyan et al. 1980; Malangoni and Condon 1983; Wood et al. 1988; Dinneen et al. 1989; Perez et al. 1998). In 1988, Wood et al. characterized traumatic hernia into three types: (1) small lower quadrant abdominal defects and inguinal hernias, mostly the result of blunt trauma by bicycle handlebars, (2) larger abdominal wall defects sustained in motor vehicle accidents, and (3) intra-abdominal herniations (Wood et al. 1988). Different patterns of muscular and fascial disruption can occur due to different types of force, ranging from small tears to large disruptions (Drago et al. 1999). Persistent cough has been identified as a cause for traumatic hernia (Vasquez et al. 1999). The traumatic hernia may be accompanied by large bowel strangulation, small bowel perforation, acute incarceration, nerve and vessel injuries (Antonie 1951; Hennessy 1954; Katzen 1958; Mucciolo and Godec 1988; Reynolds 1995; Aszmann et al. 1997; Nussbaumer et al. 2000; Omncel et al. 2003; Mahajna et al. 2004). Unusual forms of traumatic hernia may be associated with pubic diastasis, parapubic hernia and herniation of the bladder (Jacques et al. 1988; Losanoff et al. 2002).

### SPORTSMAN'S HERNIA

Suspected causes of sports hernia include weakness of the posterior wall with occult direct or indirect hernia (Hackney 1993; Yilmazlar 1996), injury of the internal oblique muscle or fascia (Taylor et al. 1991, Simonet et al. 1995), injury of the external oblique muscle or aponeurosis with ilioinguinal nerve entrapment (Williams 1995; Lacroix 1998), or nerve entrapment, e.g., obturator nerve, genital branches of the genitofemoral nerve, associated with pathological changes of the fascia (Bradshaw et al. 1997, Akita et al. 1999, Ziprin et al. 1999). According to Joesting (2002) the underlying defect is most likely a tear of the transversalis fascia. Adductor action during sport-

ing activities creates shearing forces that can stress the posterior inguinal wall (Hackney 1993; Simonet et al. 1995), or repetitive stretching of the transversalis fascia and the internal oblique can lead to separation from the inguinal ligament (Kumar et al. 2002). Also abnormalities with the rectus abdominus insertion (Anderson 2001), or pressure-overload syndrome (Dickerman et al. 2004) have been discussed as cause of sportsman's hernia. Although there is some disagreement, the defect in the posterior wall has been found in a very high proportion (>25%) of the adult population (Gulmo 1980; Skandalakis et al. 1989; Skandalakis et al. 1994; Schumpelick et al. 1994). In fact it has been demonstrated that after repair of a posterior wall deficiency both the injured and non-injured side improved significantly in strength. The strength of the abdominal oblique showed the most significant improvement (Hemingway et al. 2003).

## DIAGNOSIS

### INGUINAL HERNIA

Diagnosis of classic inguinal hernia is mostly straightforward using physical and ultra-sound examination. CT-scan, MRT, x-rays are not recommended for routine use (Conze et al. 2004). The differential diagnosis includes mainly disorders of the groin region (Malanconi and Gagliardi 2004).

### TRAUMATIC HERNIA

In traumatic hernia further evaluation by conventional radiology, CT-scan, arteriogram, bowel contrast studies or colour duplex sonography may be necessary (Dimyan et al. 1980; Carter et al. 1981; Guly and Stewart 1983; Wood et al. 1988). Especially in the case of handlebar injuries ultrasound may be helpful (Losanoff et al. 2002; Robinson 2002). It is mandatory to exclude hematoma (Guly and Stewart 1983; Fraser et al. 2002), spermatic cord hematoma (McKenney et al. 1996), iliac or femoral artery disruptions or thrombosis (Moskovitz 1961; Millikan et al. 1981; Digby et al. 2000), and testicular dislocation/torsion/tumor or scrotal enlargement (Feder et al. 1991; McKenney et al. 1996; Mhoon et al. 2002).

### SPORTSMAN'S HERNIA

The actual source of pain and the best method for diagnosis of sportsman's hernia remain unclear. The detection of this hernia has been reported by some authors and rejected by others (Orchard et al. 1998; Orchard et al. 2000; Joesting 2002). The recent literature shows that hernia to be an often-overlooked cause of chronic groin pain (Ekberg et al. 1988; Karlsson et al. 1994; Lovell 1995; Swain and Snodgrass 1995). In one series only 8% of patients with abdominal or inguinal hernias had detectible hernias on physical examination (Amaral 1997). In more than 90% of patients a true pathological alteration, e.g., indirect hernia, wide internal ring, has been identified (Susmallian et al. 2004). It is clear, however, that laparoscopic proce-

dures, as used in that study, may not be able to discover tears in the transversalis fascia. The leading symptom which should alert the physician to the possibility of sportsman's hernia is pain which responds poorly to traditional measures, including prolonged rest and which usually resurges after return to activity (Zimmerman 1988; Gullmo 1989; Gilmore 1992; Lynch and Renström 1997; Ruane and Rossi 1998). Imaging, to identify occult hernias, has not been useful with the exception of ultrasonography, which allows a dynamic assessment of hernias (Gullmo 1989; Macarthur et al. 1997; Robinso 2002). Herniography, although successful in some series, has not been recommended for routine use (Amaral 1997; Kemp and Batt 1998). The same is true for CT-scan and MRT, which were beneficial in some instances but showed poor correlation with the severity of injury in others (Dubois and Freeman 1981; Elkberg et al. 1996; Fon and Spence 2000; Uppot et al. 2000; Hickey et al. 2002). Focused history questions and physical exam maneuvers are especially important with groin pain because symptoms can arise from any of numerous causes, sports related or not (Lacroix 2000). Despite the overwhelming evidence, the sports hernia has not been universally accepted as cause of groin pain (Fredberg and Kissmeyer-Nielsen 1996). The concept of sportsman's hernia is supported by the success of surgery, the anatomical relationship between pain and the surgical solution, and the demonstration of the deficiency of the posterior wall both surgically and with imaging modalities (Orchard et al. 2000; Joesting 2002; Susmallian et al. 2004). The diagnosis of sportsman's hernia is complicated by the differential diagnosis including the complex anatomy of the region and the frequent coexistence of two or more disorders (Ekberg et al. 1988; Fricker et al. 1991) which leaves the physician in 30% of cases with an unclear diagnosis (Roos 1997). Most common groin injuries are soft tissue injuries, such as muscular strains, tendonitis, or contusions (LeBlanc and LeBlanc 1999), but the list of differential diagnoses is long and may include intra-abdominal, genito-urinary, lumbosacral, hip, local groin, pelvis and lower extremity causes (Estwanick et al. 1990; Bradshaw et al. 1997; Johnston et al. 1998; Ruane and Rossi 1998; O'Kane 1999; Adkins and Figler 2000; Morelli and Smith 2001; Verrall et al. 2001; Nicholas and Tyler 2002; Orchard 2003; Hess 2004). Perhaps the most important task in diagnosis is delineating whether the injury is acute or chronic (Ruane and Rossi 1998).

## TREATMENT

### INGUINAL HERNIA

The treatment of inguinal hernia is a cause for constant debate among surgeons. Tension-free hernia repair has been praised for its excellent results, but larger studies for a better comparison of open and laparoscopic repairs were demanded (Conze et al. 2001). In 2004, Neumayer et al. reported on the results of a large randomized study comparing open-mesh versus laparoscopic treatment of inguinal hernia and showed that the risk for recurrence is less than half after open-

mesh procedures when compared to laparoscopic procedures. With regard to complications, there are some types of complications, which seem to be seen more often or only after laparoscopic hernia repair, e.g., migrating mesh plug (Morrman and Price 2004), intestinal obstruction Rink and Ali 2004), nerve damage (Lantis and Schwaitzberg 1999), enterocutaneous fistula (Klein and Banever 1999), cardiopulmonary changes (Lehmann et al. 1995; Makinen and Yli-Hankala 1998), pneumothorax (Ferzli et al. 1997), thromboembolism (Catheline et al. 2000; Holzheimer 2004), pneumomediastinum (Madan et al. 2003), arteriovenous fistula (Ovrouski et al. 2001), gas extravasation (Hagopian et al. 2001), trocar and Veress needle injuries (Schäfer et al. 2001), and intraperitoneal adhesions (Eller et al. 1997). According to recent meta-analyses laparoscopic hernia repair is associated with an increased risk for serious complications (Grant 2002; Voyles et al. 2002). In 2003, Memon et al. reported a trend towards an increase in the relative odds of recurrence after laparoscopic repair. The observed quicker return to work and normal activities may be influenced by other co-factors. In France, there was a higher frequency of laparoscopy in middle aged patients, without important comorbidity, in private hospitals (Lienhart et al. 2003). The use of synthetic mesh reduces the risk of hernia recurrence and appears to reduce the chance of persisting pain (EU Hernia Trialists Collaboration 2002; Scott et al. 2002).

#### TRAUMATIC HERNIA

In traumatic hernias the recommendation for surgical repair was not always clear with regard to the timing (Guly and Stewart 1983). In 1988, Wood advocated early exploration and repair because of the high incidence of other associated intra-abdominal injuries. After adequate debridement a solid repair of fascial planes with non-absorbable sutures were required to prevent recurrence. Mesh repair may offer the advantage on preventing recurrence but may be contraindicated in hollow viscus injuries (Drago et al. 1999). The decision which mesh system should be used needs further evaluation (Zib and Gani 2002).

#### SPORTSMAN'S HERNIA

The proposals for treatment of sportsman's hernia do not always emphasize the advice for timely surgery (Orchard et al. 2000; Rupp et al. 2004). A hernia repair is indicated in case of pain and clinical or imaging evidence of a hernia or posterior wall deficit (Orchard et al. 1998). Surgical repair should be considered for patients, who have large or symptomatic inguinal hernias because of the increased risk of incarceration and strangulation of herniated tissue (Tucker and Marron 1984; Moeller 1996). Surgical reinforcement of the inguinal wall was associated with a marked improvement in the median pain score and 93% of the patients were able to return to sport after a median of 14 weeks (Kumar et al. 2002). This is supported by several other recent studies with successful outcome (good or excellent) following surgery ranging from 63% to almost 100% (Poglase et al. 1991; Taylor et al. 1991; Malycha

and Lovell 1992; Simonet et al. 1995; Williams and Foster 1995; Urquart et al. 1996). Over 9 years Gilmore repaired 360 injuries with open technique by using a 6-layered reinforcement of transversalis fascia. Approximately 97% of his patients returned to competitive sports by the 10th week after postoperative care (Gilmore 1992; Gilmore 1998; Brannigan 2000). Van der Donckt (2003) reported successful surgical treatment of chronic groin pain by Bassini's repair. Simonet has used synthetic mesh repair (1995). The guiding principle is to normalize the damaged anatomy and to reinforce the normalized anatomy with mesh. There are features to this dissection and repair that are different than traditional repair. The dissection of the cord away from the inguinal floor needs to be so meticulous that one can actually differentiate a pre-existing tear from one caused by an aggressive rough surgeon mobilizing the cord (Joesting 2002). A few studies demonstrated successful outcome following laparoscopic repair of sports hernia, suggesting that the posterior position of the mesh behind the conjoint tendon and pubic bone should create a stronger repair than conventional surgery (Ingoldby 1997; Evans 1999; Genitsaris et al. 2004; Kluin et al. 2004; Paajanen et al. 2004; Susmallian et al. 2004). The overall complication rate of the laparoscopic sportsman's hernia treatment is poorly documented in the literature and remains to be determined (Kumar et al. 2002). Important disadvantages of laparoscopic procedures are the failure to visualize, evaluate and repair the transverse fascial tear and that laparoscopic procedure requires general anaesthesia. Proposed advantages, e.g., pain reduction and reduction of disability, are not seen by all authors (Joesting 2002). Laparoscopic hernia repair may be associated with nerve injuries (Parker et al. 1998; Lange et al. 2003) and defects in urinary and sexual function (Kux 2002; Butler et al. 1998; Callessen and Kehlet 1997; Borchers et al. 2001; Brown and Dahl 2004).

#### PRESENT CLASSIFICATION

The classification of inguinal hernia has been considered as a useful tool for the surgeon to decide which type of hernia repair may be the best in the individual patient. Several important contributions were made by American, French and German surgeons. Classifications, therefore, are not regarded as eternally firm constructions, but reflect the developments in hernia surgery.

#### CASTEN CLASSIFICATION 1967

The difficulties in classifying the various anatomic types of hernias were recognized more than 30 years ago when Casten, in 1967, classified the inguinal hernia according to three functional structures: transversalis fascia, transverses abdominis aponeurosis, and ileopectineal or Cooper's ligament (Casten 1967).

#### HALVERSON AND McVAY CLASSIFICATION 1970

In 1970, Halverson and McVay categorized the inguinal hernia based on pathologic anatomy and repair techniques in four classes: small indirect inguinal her-

nia, medium indirect inguinal hernia, large indirect and direct inguinal hernia, femoral hernia (Halverson and McVay 1970).

#### GILBERT CLASSIFICATION 1989

In 1989, Gilbert published his classification system on anatomic and functional defects established intraoperatively : the presence or absence of a peritoneal sac, the size of the internal ring, and the integrity of the posterior wall (Gilbert 1986). Rutkow and Robbins added the combined direct and indirect hernia and the femoral hernia to this classification system (Rutkow and Robbins 1993).

#### NYHUS CLASSIFICATION 1991

Nyhus used anatomic criteria, e.g., size of the internal ring and integrity of the posterior wall, to classify the inguinal hernia (Nyhus 1991) (Table 3).

#### BENDAVID CLASSIFICATION 1993

Bendavid has proposed the T.S.D. (Type, Staging, and Dimension) system which includes five types of groin hernia and three stages for each type. In this classification Bendavid emphasizes the extension (sliding) of the hernia which may lead to destruction of important functional structures, e.g., lacunar ligament, inguinal ligament (Rutkow and Robbins 1993; Bendavid 2002). (Table 4)

#### AACHEN CLASSIFICATION 1995

The Aachen classification has introduced the diameter measurement of the hernia orifice to the lateral, medial, combined and femoral hernia (Conze et al. 2001). (Table 5)

#### ZOLLINGER CLASSIFICATION 2003

In 2003, Zollinger presented a modified traditional classification that included all the classes or grades within the Nyhus-Stoppa, Gilbert, and Schumpelick-Arlt systems. This modified classification grades the size of the hernia in small, medium, and large using "fingertips" or "fingerbreadths" for measurement. The large indirect hernia is characterized by a disrupted internal ring that is greater than 4 cm or two fingerbreadths in width, whereas the large direct hernia is defined by a complete blowout of the entire floor (Zollinger 2003) (Table 6).

#### STRONG AND WEAK POINTS OF THE DIFFERENT CLASSIFICATIONS

All classifications have in common that they use the size of the hernia and the status of the posterior floor and/or the internal ring to describe the hernia. In these classifications the important issue is to describe whether or not the posterior floor, which is the main factor for the development of a hernia, is involved. It is assumed that the size of a hernia is associated with a more severe form of hernia. However, patients with

Table 3. Nyhus classification (Nyhus 1993).

Type 1	Indirect inguinal hernia with a normal ring Sac in the canal
Type 2	Indirect hernia with an enlarged internal ring but the posterior wall is intact; inferior deep epigastric vessels not displaced, sac not in scrotum
Type 3a	Direct hernia with a posterior floor defect only
Type 3b	Indirect hernia with enlargement of internal ring and posterior floor defect
Type 3c	Femoral hernia
Type 4	Recurrent hernia A direct B indirect C femoral D combinations of A-B-C

Aggravating factors : local or systemic, upstage type by 1 (Stoppa 1998)

Table 4. Bendavid classification 1994 (From Rutkow and Robbins 1994).

<b>Type 1</b>	<b>Anterolateral or indirect</b>
Stage 1	Extends from the deep inguinal ring to the superficial ring
Stage 2	Goes beyond the superficial ring but not unto the scrotum
Stage 3	Reaches the scrotum
<b>Type 2</b>	<b>Anteromedial or direct</b>
Stage 1	Remains within the confines of the inguinal canal
Stage 2	Goes beyond the superficial ring but not into the scrotum
Stage 3	Reaches the scrotum
<b>Type 3</b>	<b>Posteromedial or femoral</b>
Stage 1	Occupies a portion of the distance between the femoral vein and the lacunar ligament
Stage 2	Goes the entire distance between the femoral vein and the lacunar ligament
Stage 3	Extends from the femoral vein to the pubic tubercle (recurrences, destruction of the lacunar ligament)
<b>Type 4</b>	<b>Posterolateral or prevascular</b>
Stage 1	Located medial to the femoral vein: Cloquet and Laugier hernia
Stage 2	Located at the level of the femoral vessels: Velpeau and Serafini hernias
Stage 3	Located lateral to the femoral vessels: Hesselbach and Partridge hernias
<b>Type 5</b>	<b>Anteroposterior or inguinofemoral</b>
Stage 1	Has lifted or destroyed a portion of the inguinal ligament between the pubic crest and the femoral vein
Stage 2	Has lifted or destroyed the inguinal ligament from the pubic crest to the femoral vein
Stage 3	Has destroyed the inguinal ligament from the pubic crest to a point lateral to the femoral vein

Table 5. Aachen classification (Schumpelick and Arlt 1995)

Classification	Type
L	Lateral hernia
M	Medial hernia
Mc	Combined hernia
F	Femoral hernia
I	Hernia orifice < 1.5 cm
II	Hernia orifice 3 cm
III	Hernia orifice >3cm

Table 6. Modified traditional classification (Zollinger 2003)

I	A	Indirect small
	B	Indirect medium
	C	Indirect large
II	A	Direct small
	B	Direct medium
	C	Direct large
III		Combined
IV		Femoral
O	Other	Any not classified by number above Femoral + indirect or direct Femoral + indirect + direct Massive > 8cm (4 fingers) inguinal defect prevascular
R	Recurrent	

Defect size: A < 1.5 cm; B 1.5 to 3 cm; C > 3cm

small hernias may experience increased postoperative pain (Schmitz et al. 1999). While it may be easy for the general surgeon to determine that the internal ring or the posterior floor is defect, how can he be sure that his hernia is medium sized? The description of size is always subject to personal estimation. It is also evident that the outcome of a hernia repair may be influenced by local and systemic co-factors. The classification of inguinal hernia should include the posterior floor status but also the defect caused by the hernia in the surrounding tissue of the abdominal wall. The lower abdominal wall is composed of several layers which function together as a solitary unit to prevent herniation through an anatomic hole, although each layer is a distinct anatomic structure (Fagan and Awad 2004). The significance of the posterior floor for the herniation has been elaborated by many authors (Condon 1989). The posterior wall is formed primarily by fusion of the aponeurosis of the transversus abdominis muscles and the transversalis fascia. The integrity of a normal inguinal canal depends upon the sphincteric action of the transversus abdominis and internal oblique muscles at the internal ring and the shutter action of the transversus abdominis aponeurosis, which forms the transversus arch. (Skandalakis et

al. 1993). The function of the inguinal canal, sphincteric action of the internal ring, and shutter action of the transversus abdominis and internal oblique muscle, is rather complex. A deficient posterior wall, found in about 25% of patients, lacks the support of the aponeurosis of the transversus abdominis muscle. The transversalis fascia, a thin layer of connective tissue, is then the only anatomic structure contributing to the continuity of the floor (McVay 1971). However, the function of the inguinal canal is also supported by the the aponeurosis of the external oblique and the inguinal ligament. The medial inguinal floor is covered by the aponeurosis of the external oblique and the investing layer of the transversus abdominis muscle or transversalis fascia (Bendauid 2001). The hernia, which causes damage to this structure, e.g., aponeurosis of the external oblique, inguinal ligament, external ring, can be classified as a different entity than a medium or large hernia, which leaves these structures intact. A defect of the aponeurosis of the external oblique or of the inguinal ligament is clearly visible and is a reproducible marker for the severity of an existing hernia. This may also allow to include traumatic and Sportsman's hernia.

#### AGGRAVATING FACTORS

In a patient with a groin hernia a defect in the posterior floor and defects in the anterior part of the inguinal canal, e.g., aponeurosis of the external oblique, external ring, inguinal ligament, are easily recognized by the surgeon. In case of a long-standing hernia, there may be massive adhesions contributing to the difficulties in dissection. Diminished fibrin degradation is a common pathway for the formation of adhesions (Reijnen et al. 2003). High friction (Zhao et al. 2001), inflammatory reaction (Luijendijk et al. 1996), and ischemic tissue (Ellis 1971) have been found to cause adhesions. These changes have significant effects on the surgical treatment. Extensive dissection to free the sac from the cord or the adjacent tissue, especially in patients with large sliding inguinal hernias, may be demanding and there is an increased risk for complications (Wantz 1984). The significance of aggravating factors – complex injuries related to the hernia (size, degree of sliding, multiplicity, etc.), patient characteristics (age, activity, respiratory disease, dysuria, obesity, constipation) or special surgical circumstances (technical difficulties, infection risk) have been demonstrated by Stoppa in 1998.

#### PATIENT RELATED FACTORS INCREASING THE RISK OF POSTOPERATIVE COMPLICATION AND RECURRENCE

Postoperative complications and comorbidity may increase the relative risk for re-operation after hernia repair (Haapaniemi et al. 2001). Coexisting cardiopulmonary diseases, American Society of Anesthesiologists class, late admission, emergency repair, older age (> 65 years), raised abdominal pressure, coexisting infection, previous infection in the groin, incisional hernia, low serum albumin, steroid use, smoking, alcohol abuse, previous surgery in the lower abdomen, anatomical

characteristics of the hernia, family history of hernia, obstipation, chronic cough, diabetes, varicose veins and previous thromboembolism (Nehme 1983; Dey-sine et al. 1987; Houck et al. 1989; Simchen et al. 1990; Schaap et al. 1992; Carbonell et al. 1993; Akin et al. 1997; Liem et al. 1997; Franchi et al. 2001; Kulah et al. 2001; Lodding et al. 2001; Sorensen et al. 2002; Dunne et al. 2003, Holzheimer 2004). While it has been suggested by some authors that obesity may be a protective factor against hernia formation (Thomas and Barnes 1990; Liem et al. 1997), in more recent publications obesity has influenced the occurrence of hernia (Franchi et al. 2001; DeLuca et al. 2004).

#### VARICOSE VEINS, HEMORRHOIDS AND ABDOMINAL AORTIC ANEURYSM – COLLAGEN DISORDER AS RISK

The prevalence of hernia was significantly higher in the presence of varicose veins, and hemorrhoids (Abramsin et al. 1978). There has been observed a statistical association among abdominal aortic aneurysm (AAA), inguinal hernia and abdominal wall hernia directing the search for causes of hernia to collagen disorders (Musella et al. 2001). Men with a history of inguinal hernia are at increased risk of AAA, most notably if they are cigarette smokers (Pleumeekers et al. 1999). The significance of a previous appendectomy on hernia formation remains unclear. Dissection, however, may be more difficult (Tobin et al. 1976; Arnbjornsson 1982; Malazgirt et al. 1992; Vecchio et al. 2002; Lau and Patil 2004) and there may be always a possibility of nerve entrapment after lower abdominal surgery (Stulz and Pfeiffer 1982; Sippo and Gomez 1987).

#### DURATION OF HERNIA

The duration of hernia may be a possible factor for a detrimental outcome. The cumulative probability of irreducibility of inguinal hernia increases from 6.5% at 12 months to 30% at 10 years (Hair et al. 2001). The cumulative probability of strangulation for inguinal hernia was 2.8% after 3 months, rising to 4.5% after 2 years. In case of femoral hernia the risk was 22% at the third months and 45% at 21 months. (Gallegos et al. 1991). Complicated presentations of groin hernias are associated with a higher proportion of women and patients with femoral hernias (Oishi et al. 1991). Especially older patients should be informed on the high risk of complications in emergency hernia operations (Rorbaek-Madsen 1992). Then, the short duration of the hernia may be considered a detrimental factor (Rai et al. 1998).

#### INFECTION AS RISK FOR RECURRENCE

The incidence of groin infection, which increases the risk for reoperation, may be more frequent than previously reported. The median interval for reoperation of the infected groin has been 4 months (2 weeks – 39 months) (Taylor and O'Dwyer 1999). Wound complications were observed in 5.9% of patients (Hoffman and Traverso 1993). In 1992, Bailey reported a wound infection rate of 3% in the hospital, which increased to 9% in case of community surveillance. Wound compli-

cations were recorded in 7% of cases in the hospital and in 28% by community surveillance.

#### OPERATIVE TECHNIQUE AND TYPE OF ANAESTHESIA AS RISK FOR RECURRENCE

Operative technique and type of anaesthesia may influence the outcome after hernia repair. A significant effect of local anaesthesia on recurrence has been reported by several groups (Sorensen et al. 2002; Nordin et al. 2004), which is controversial to the results published by the Lichtenstein group (Lichtenstein et al. 1989). Direct recurrence after Lichtenstein repair may be caused by insufficient medial mesh fixation and overlap over the pubic tubercle (Bay-Nielsen et al. 2001). Intestinal obstruction and other complications may occur more often after TAPP than after open mesh repair (Duron et al. 2000). However, Bay-Nielsen found no difference in the incidence of pain with regard to type of hernia, surgical repair and type of anaesthesia (Bay-Nielsen et al. 2001). In 1996, Cunningham et al. have indicated that the absence of a visible bulge before the operation, the presence of numbness in the surgical area postoperatively, and patient requirement of more than four weeks out of work postoperatively may indicate long-term postoperative pain. The risk of postoperative urinary retention may be increased by the use of general anaesthesia, and the perioperative administration of more than 1,200 ml fluid in patients older than 53 years (Petros et al. 1991). However, it should be noted that most compounds used for treatment of psychological disorders may influence as well the urinary retention.

#### SOCIAL HUMAN FACTORS

The recent developments in pain prevention, anaesthesia, surgical technique and material led to a situation where painless patients may feel to have almost unrestricted mobility. The desire to practise their usual sport or hobby shortly after the operation is no longer restricted by postoperative faintness or pain. Some patients think that activities which put strain on the groin like hunting of venison, wind-surfing at wind-force 6 or heavy-weight lifting are possible during the postoperative recovery. No pain, no risk could be detrimental. The hunter's success in the Bavarian Alps with the venison on his back could be the surgeon's nightmare. Human factors influencing resumption of normal activity are rarely reported. Dispositional pessimism may correlate strongly with a delayed return to normal activities (Bewley et al. 2003). Type of insurance coverage influences postoperative recovery time after hernia repair (Salcedo-Wasicek and Thirlby 1995). Other factors influencing the risk associated with inguinal hernia were physical activity and education (Carbonell et al. 1993; Haapanen-Niemi et al. 2000; Leveille et al. 2000). Work, involving heavy lifting, may favour the development of groin hernia (Flich et al. 1992; Miller 2004)

#### SCROTAL HERNIA

Dissection beyond the pubic tubercle is necessary in patients with giant hernias that descend to the scro-

tum. Massive scrotal or giant hernias may not only contain small bowel or large bowel but are accompanied by a loss of domain. These giant inguinal hernias are rare, but do require special consideration for repair of the abdominal wall (Hodkinson and McIlrath 1984; King et al. 1986).

#### FEMORAL HERNIA

In case of the femoral hernia the true inner ring is formed by the iliopubic tract anteriorly and medially, and by Cooper's ligament posteriorly. Acquired weakness of the transversalis fascia and elevated intra-abdominal pressure are key factors for the development of a femoral hernia (Hachisuka 2003). With regard to damage to the inguinal canal and to the type of the treatment, the differentiation in direct or indirect hernia may be irrelevant. According to Devlin (1997) the defect in all hernias – direct, indirect, femoral – is a structural alteration in the fascia transversalis, and the posterior floor is defect in both of these types of hernia. A study of 34849 groin repairs demonstrated a 15-fold greater incidence of femoral hernia after inguinal herniorrhaphy compared with the spontaneous incidence (Mikkelsen et al. 2002).

#### RECURRENT HERNIA

Recurrent hernia is often considered to be caused by deficient surgical technique and surgeons are very sensitive with regard to this topic. Recurrence may occur early within one or two years and an undue tension on suture lines has been determined as principal cause (Lichtenstein et al. 1993). In late recurrence a disorder of collagen metabolism may be the underlying defect (Read and McLeod 1981). In secondary operations for recurrent hernia there may be multiple defects, e.g., true recurrence and/or additional hernia, which demand more efforts in the dissection of the inguinal canal (Zimmerman 1958). The incidence of moderate or severe pain is higher after repair of recurrent hernias (Callesen et al. 1999). Recurrent hernia repair is told to have a higher recurrence rate (Kux et al. 1994).

#### BILATERAL HERNIA

The risk for recurrent hernia after the bilateral repair of inguinal hernia has not been determined. Szymanski and Voitk (2001) considered patients with recurrent hernia or simultaneously repaired bilateral hernias as high risk for recurrence. However, recent results from the Swedish hernia center do not support this (Kald 2002).

#### INCARCERATED HERNIA

As indicated by Rutkow and Robbins, there may be variables, which are difficult to account for: sliding, reducible/incarcerated, lipoma (Rutkow and Robbins 1993). An incarcerated or strangulated hernia is a complication of a hernia. The outcome of incarcerated hernia may be similar no matter what type of hernia. The overlying pathogenesis is the damage of the bowel which needs to be resected if not viable (Hachisuka 2003). Older age, severe coexisting diseases and late

hospitalization are main causes of unfavourable outcomes in the management of incarcerated hernias. The overall complication rate may be 19.5%, of which major complications were 15.1% (Kulak et al. 2001). Incarcerated hernia has been considered a complicated presentation of groin hernia (Oishi et al. 1991).

#### PROPOSAL FOR A SURGERY-BASED CLASSIFICATION

An adapted classification on inguinal hernia may be helpful in several aspects of hernia surgery: strategy for dissection of the inguinal canal (landmarks), comparison of surgical repairs, evaluation of postoperative follow-up, complications and quality of life. Based on intra-operative findings the classification of hernia may be simple: (A) indirect, (B) direct, (C) giant or scrotal, (D) femoral, and other rare hernias, e.g., Spieghele hernia, lumbal hernia, supravescical hernia, hernia obturatoria, hernia ischiadica, hernia perinealis (Montes and Deysine 2003; Schumpelick 2000). The type of hernia is then graded as (1) uncomplicated without defect in the posterior wall or in the internal ring (1), and then - according to the defect in the abdominal wall – as (2) with defect in the posterior floor and (3) with defect in the posterior floor plus defect in either the aponeurosis of the external oblique and/or external ring and/or inguinal ligament. Scrotal or giant hernia and femoral hernia are considered to have a defect in the posterior wall with change in other supporting elements of the abdominal wall. Each type of hernia may then be classified as primary or recurrent inguinal hernia. (Table 1) A modified classification, including aggravating factors, may be used for a numerical classification of the severity of hernia (Table 2). In this classification combined femoral, indirect and/or direct hernias can be categorized by using the types A,B,C, or D as in a modular construction system. The category "other" is reserved for rare types of hernia, e.g., obturator hernia, Spieghele hernia.

#### INDIVIDUAL REPAIR ACCORDING TO CLASSIFICATION

The most widely accepted Nyhus classification has been designed and accepted to guide the surgeon's decision what type of repair should be used, e.g., Shouldice or mesh. In the United States, according to observations of Rutkow and Robbins the preferred method for inguinal hernia repair is open mesh, regardless of the Nyhus type of inguinal hernia (Rutkow and Robbins 1998; Awad 2004). Should we treat all hernias with mesh? In case of small hernias or sportsman's hernia – without a large defect of the posterior wall – surgical therapy is best when tailored according to the status of the inguinal canal, e.g., Shouldice repair instead of Lichtenstein. Mesh plug fixation of the inguinal hernia may not be suitable for all types of hernias.

Inguinal hernias with posterior floor defect and/or defect of the aponeurosis of the external oblique or defect of the inguinal ligament may benefit from treatment with tension-free Lichtenstein repair (Holzheimer 2004). The success of the open-mesh

technique should not tempt us to think every hernia is equal. Groin hernias may be complex and need individual treatment.

#### REFERENCES

- Abramson JH, Gofin J, Hopp C, Makler A, Epstein LM. The epidemiology of inguinal hernia. A survey in western Jerusalem. *J Epidemiol Community Health* 1978;32(1):59-67
- Adkins SB, Figler RA. Hip pain in athletes. *Am Fam Phys* 2000;61:2109-18
- Akin ML, Karakaya M, Batkin A, Nogay A. Prevalence of inguinal hernia in otherwise healthy males of 20 to 22 years age. *J R Army Med Corps* 1997;143(2):101-102
- Akita K, Niga S, Yamato Y, Muneta T, Sato T. Anatomic basis of chronic pain with special reference to sports hernia. *Surg Radiol Anat* 1999;21(1):1-5
- Al-Qasabi QO, Tandon RC. Traumatic hernia of the abdominal wall. *J Trauma* 1988;28:875-876
- Anderson K, Strickland SM, Warren R. Hip and groin injuries in athletes. *Am J Sports Med* 2001;29:521-532
- Antonie T. Traumatic rupture of the intestine in relation to inguinal hernia: report of a case. *Med J Aust* 1951;2(23):779
- Arnbjornsson E. A neuromuscular basis for the development of right inguinal hernia after appendectomy. *Am J Surg* 1982;143(3):367-369
- Aszmann OC, Dellon ES, Dellon AL. Anatomical course of the lateral femoral cutaneous nerve and its susceptibility to compression and injury. *Plast Reconstr Surg* 1997;100(3):600-4
- Awad SS. Evidence-based approach to hernia surgery. *Am J Surg* 2004;188 (Suppl.):1S-2S
- Bailey IS, Karran SE, Toyn K, Brough P, Ranaboldo C, Karan SJ. Community surveillance of complications after hernia surgery. *BMJ* 1992;304(6825):469-471
- Bay-Nielsen M, Perkins FM, Kehlet H. Danish Hernia Database. Pain and functional impairment 1 year after inguinal herniorrhaphy: a nationwide questionnaire study. *Ann Surg* 2001;233(1):1-7
- Bay-Nielsen M, Nordin P, Nilsson E, Kehlet H. Danish Hernia Data Base and the Swedish Hernia Data Base. Operative findings in recurrent hernia after a Lichtenstein procedure. *Am J Surg* 2001;182(2):134-136
- Bendavid R. The transversalis fascia: new observations. In: Bendavid R, ed. *Abdominal wall hernias. Principle and Management*. New York Springer 2001:97-100
- Borchers H, Brehmer B, van Poppel H, Jakse G. Radial prostatectomy in patients with previous groin hernia repair using synthetic mesh. *Urol Int* 2001;67:213-215
- Bowley DM, Butler M, Shaw S, Kingsnorth AN. Dispositional pessimism predicts delayed return to normal activities after inguinal hernia operation. *Surgery* 2003;133(2):141-146
- Bradshaw C, McCrory P, Bell S, Brukner P. Obturator nerve entrapment: a cause of chronic pain in athletes. *Am J Sports Med* 1997;25(3):402-408
- Brannigan AE, Kerin MJ, McEntee GP. Gilmore's groin repair in athletes. *J Orthop Sports Phys Ther* 2000;30(6):329-32
- Brown JA, Dahl DM. Transperitoneal laparoscopic radical prostatectomy in patients after laparoscopic prosthetic mesh inguinal herniorrhaphy. *Urology* 2004;63:380-382
- Butler JD, Hershman MJ, Leach A. Painful ejaculation after inguinal hernia repair. *J R Soc Med* 1998;91:432-433
- Callesen T, Kehlet H. Postherniorrhaphy pain. *Anesthesiology* 1997;87:1219-1230
- Callesen T, Bech K, Kehlet H. Prospective study of chronic pain after groin hernia repair. *Br J Surg* 1999;86(12):1528-1531
- Carbonell JF, Sanchez JL, Peris RT, Ivcora JC, Del Bano MJ, Sanchez CS, Arraez JI, Greus PC. Risk factors associated with inguinal hernias: a case control study. *Eur J Surg* 1993;159(9):481-486
- Carter SL, McKenzie JG, Hess DR. Blunt trauma to the common femoral artery. *J Trauma* 1981;21(2):178-179
- Casten DF. Functional anatomy of the groin area as related to the classification and treatment of groin hernia. *AM J Surg* 1967;114:894-899
- Catalano FE, Perez JG. Traumatic hernial sac rupture. *Sem Med* 1962;121:1583-4
- Catheline JM, Capelluto E, Gaillard JL, Turner R, Champault G. Thromboembolism prophylaxis and incidence of thromboembolic complications after laparoscopic surgery. *Int J Surg Investig* 2000;2(19):41-47
- Condon R. The anatomy of the inguinal region and its relation to groin hernia. In: Nyhus, Condon RE, eds. *Hernia* 3rd edition Philadelphia Lippincott 1989:18-61
- Conze J, Klinge U, Schumpelick V. Hernias. In: *Surgical treatment - evidence-based and problem-oriented*. Holzheimer RG, Mannick JA (eds.). Zuckschwerdt Verlag München Bern Wien New York 2001:611-618
- Cunningham J, Temple WJ, Mitchell P, Nixon JA, Preshaw RM, Hagen NA. Cooperative hernia study. Pain in the postrepair patient. *Ann Surg* 1996;224(5):598-602
- Damschen DD, Landercasper J, Cogbill TH, Stolee RT. Acute traumatic abdominal hernia: case reports. *J Trauma* 1994; 36:273-276
- Davis CJ, Arregui ME. Laparoscopic repair for groin hernias. *Surg Clin North Am* 2003;83:1141-1161
- De Luca L, Di Giorgio P, Signoriello G, Sorrentino E, Rivellini G, D'Amore E, De Luca B, Murray JA. Relationship of hiatal hernia and inguinal hernia. *Dig Dis Sci* 2004;49(2):243-247
- Devlin HB. Tailor the repair to the hernia. In Schein M and Wise L (eds): *Crucial controversies in surgery*. Karger Landes Basel 1997:57-63
- Deysine M, Grimson R, Soroff HS. Herniorrhaphy in the elderly. Benefits of a clinic for the treatment of external abdominal wall hernias. *Am J Surg* 1987;153(4):387-391
- Dickerman RD, Smith A, Stevens QE. Umbilical and bipossible exception of herniography and ultrasonography to identify lateral inguinal hernias in a veteran powerlifter: is it a pressure-overload syndrome? *Clin J Sport Med* 2004;14(2):95-96
- Digby J, Sutterfield WC, Floresguerra C, Evans JR. Bilateral external iliac and common femoral artery disruptions after blunt trauma. *South Med J* 2000;93(11):1120-21
- Dimyan W, Robb J, MacKay C. Handlebar hernia. *J Trauma* 1980;20(9):812-813
- Dinneen MD, Wetter LA, Orr NW. Traumatic indirect inguinal hernia: a seat belt injury. *Injury* 1989;20(3):180
- Drago SP, Nuzzo M, Grassi GB. Traumatic ventral hernia: report of a case with special reference to surgical treatment. *Surg Today* 1999;29(10):1111-1114
- Dubois PM, Freeman JB. Traumatic abdominal wall hernia. *J Trauma* 1981;21:72-74
- Dunne JR, Malone DL, Tracy JK, Napolitano LM. Abdominal wall hernias: risk factors for infection and resource utilization. *J Surg Res* 2003;111(1):78-84
- Duron JJ, Hay JM, Msika S, Gaschard D, Domergue J, Gainant A, Fingerhut A. Prevalence and mechanisms of small intestinal obstruction following laparoscopic abdominal surgery: a retrospective multicenter trial. French Association for Surgical Research. *Arch Surg* 2000;135(2):208-212
- Ekberg O, Persson NH, Abrahamsson PA, Westlin NE, Lilja B. Longstanding groin pain in athletes. A multidisciplinary approach. *Sports Med* 1988;6:56-61
- Ekberg O, Sjoberg S, Westlin N. Sports-related groin pain: evaluation with MR imaging. *Eur Radiol* 1996;6(19):52-55

- Eller R, Bukhari R, Poulos E, McIntire D, Jenevein E. Intra-peritoneal adhesions in laparoscopic and standard open herniorrhaphy. An experimental study. *Surg Endosc* 1997;11(1):24-28
- Ellis H. The cause and prevention of postoperative intraperitoneal adhesions. *Surg Gynecol Obstet* 1971;133(3):497-511
- Estwanick JJ, Sloane B, Rosenberg MA. Groin strain and other possible causes of groin pain. *Physician Sportsmedicine* 1990;18:54-65
- EU Hernia Trialists Collaboration. Repair of groin hernia with synthetic mesh: meta-analysis of randomized controlled trials. *Ann Surg* 2002;235(3):322-332
- Fagan SP, Awad SS. Abdominal wall anatomy: the key to a successful inguinal hernia repair. *Am J Surg* 2004; 188 (Suppl):3S-8S
- Feder M, Sacchetti A, Myrick S. Testicular dislocation following minor scrotal trauma. *Am J Emerg Med* 1991;9(1):40-442
- Ferzli GS, Kiel T, Hurwitz JB, Davidson P, Piperno B, Fiorillo MA, Hayek NE, Riina LL, Sayad P. Pneumothorax as a complication of laparoscopic inguinal hernia repair. *Surg Endosc* 1997;11(2):152-153
- Flich J, Alfonso JL, Delgado F, Prado MJ, Cortina P. Inguinal hernia and certain risk factors. *Eur J Epidemiol* 1992;8(2): 277-282
- Fon LJ, Spence RA. Sportsman's hernia. *Br J Surg* 2000; 87(5):545-52
- Franchi M, Ghezzi F, Buttarelli M, Tateo S, Balesteri D, Bolis P. Incisional hernia in gynecologic oncology patients: a 10-year study. *Obstet Gynecol* 2001;97(5 Pt 1):696-700
- Fraser N, Milligan S, Arthur R, Crabbe D. Handlebar hernia masquerading as an inguinal haematoma. *Hernia* 2002;6(1):39-41
- Fredberg U, Kissmeyer-Nielsen P. The sportsman's hernia – fact or fiction? *Scand J Med Sports* 1996;6:201-204
- Fricker PA, Taunton JE, Ammann W. Osteitis pubis in athletes. Infection, inflammation, or injury? *Sports Med* 1991;12(4):266-279
- Gallegos NC, Dawson J, Jarvis M, Hobsley M. Risk of strangulation in groin hernias. *Br J Surg* 1991;78(10):1171-1173
- Ganchi P, Orgill DP. Autopenetrating hernia: a novel form of traumatic abdominal wall hernia: case report and review of the literature. *J Trauma* 1996;41:1064-1066
- Genitsaris M, Goulmaris I, Sikas N. Laparoscopic repair of groin pain in athletes. *Am J Sports Med* 2004; 32: 1238-1242
- Gilbert AI. An anatomic and functional classification for the diagnosis and treatment of inguinal hernia. *Am J Surg* 1989;157:331-333
- Gilmore OJ. Gilmore's groin – ten years experience of groin disruption. *Sports Med Soft Tissue Trauma* 1992;3(3):12-14
- Gilmore J. Groin pain in the soccer athlete: fact, fiction, and treatment. *Clin Sports Med* 1998;17(4):787-93
- Grant AM, EU Hernia Trialists Collaboration. Laparoscopic versus open groin hernia repair: meta-analysis of randomised trials based on individual patient data. *Hernia* 2002;6(1):2-10
- Gullmo A. Herniography. The diagnosis of hernia in the groin and incompetence of the pouch of Douglas and pelvic floor. *Acta Radiol Suppl* 1980;361:1-76
- Gullmo A. Herniography. *World J Surg* 1989;13:560-568
- Guly HR, Stewart IP. Traumatic hernia. *J Trauma* 1983;23(3): 250-2
- Haapanen-Niemi N, Miilunpalo S, Pasanen M, Vuori I, Oja P, Malmberg J. Body mass index, physical inactivity and low level of physical fitness as determinants of all-cause and cardiovascular disease mortality – 16 y follow-up of middle-aged and elderly men and women. *Int J Obes Relat Metab Disord* 2000;24(11):1465-1474
- Hachiuka T. Femoral hernia repair. *Surg Clin North Am* 2003;83:1189-1205
- Hackney RG. The sports hernia: a cause of chronic groin pain. *Br J Sports Med* 1993;27:58-62
- Hagopian EJ, Steichen FM, Lee KF, Earle DB. Gas extravasation complicating laparoscopic extraperitoneal inguinal hernia repair. *Surg Endosc* 2001;15(3):324
- Hair A, Paterson C, Wright D, Baxter JN, O'Dwyer PJ. What effect does the duration of an inguinal hernia have on patient symptoms. *J Am Coll Surg* 2001;193(2):125-129
- Halverson K, McVay C. Inguinal and femoral hernioplasty. *Arch Surg* 1970;101:127-135
- Haapaniemi S, Gunnarsson U, Nordin P, Nilsson E. Reoperation after recurrent groin hernia repair. *Ann Surg* 2001;234(1):122-126
- Hemingway AE, Herrington L, Blower AL. Changes in muscle strength and pain in response to surgical repair of posterior abdominal disruption followed by rehabilitation. *Br J Sports Med* 2003;37:54-58
- Hennessy JD. The association of inguinal hernia with traumatic rupture of the small intestine. *J Ir Med Assoc* 1954;35(206):255
- Hess H. Der chronische Leistenschmerz des Sportlers. *Deutsche Zeitschrift für Sportmedizin* 2004;55(4):108-109
- Hickey NA, Ryan MF, Hamilton PA, Bloom C, Murphy JP, Brenneman F. Computed tomography of traumatic abdominal wall hernia and associated deceleration injuries. *Can Assoc Radiol J* 2002;53(39):153-9
- Hodgkinson DJ, McIlrath DC. Scrotal reconstruction for giant inguinal hernias. *Surg Clin North Am* 1984;64(2):307-313
- Hoff GL. Outdoor and indoor soccer: injuries among youth players. *Am J Sports Med* 1986;14:231-233
- Hoffman HC, Traverso AL. Preperitoneal prosthetic herniorrhaphy. One surgeon's successful technique. *Arch Surg* 1993;128(9):964-969
- Holzheimer RG. First results of Lichtenstein hernia repair with ultrapro-mesh as a cost saving procedure – quality control combined with a modified quality of life questionnaire (SF-36) in a series of ambulatory operated patients. *Eur J Med Res* 2004;9(6):323-7
- Holzheimer RG. Laparoscopic procedures as a risk factor of deep venous thrombosis, superficial ascending thrombophlebitis and pulmonary embolism. Case report and review of the literature. *Eur J Med Res* 2004;9(9):417-422
- Houck JP, Rypins EB, Sarfeh IJ, Juler GL, Shimoda KJ. Repair of incisional hernia. *Surg Gynecol Obstet* 1989; 169(5):397-399
- Ingoldby CJ. Laparoscopic and conventional repair of groin disruption in sportsmen. *Br J Surg* 1997 Feb;84(2): 213-5.
- Jacques LF, Glovicki P, Patterson DE, Sarr MG. Successful repair of an unusual hernia with traumatic pubic diastasis. *Mayo Clin Proc* 1988;63(5):492-5
- Joesting DR. Diagnosis and treatment of sportsman's hernia. *Curr Sports Med Rep* 2002;1(2):121-124
- Johnston CAM, Wiley JP, Lindsay DM, Wiseman DA. Iliopsoas bursitis and tendonitis: a review. *Sports Med* 1998; 25(4):271-283
- Kald A, Fridsten S, Nordin P, Nilsson E. Outcome of repair of bilateral groin hernias: a prospective evaluation of 1,487 patients. *Eur J Surg* 2002;168(3):150-153
- Karlsson J, Sward L, Kalebo P, Thomee R. Chronic groin injuries in athletes. Recommendations for treatment and rehabilitation. *Sports Med* 1994;17:141-8
- Katzen M. A case of traumatic perforation of the intestine associated with inguinal hernia. *S Afr Med J* 1958;32(10): 274-275
- Kemp S, Batt ME. The sports hernia: a common cause of groin pain. *Phys Sportsmedicine* 1998;26(1):36-44
- King JN, Didlake RH, Gray RE. Giant inguinal hernia. *South Med J* 1986;79(2):252-253

- Klein AM, Banever TC. Enterocutaneous fistula as a postoperative complication of laparoscopic inguinal hernia repair. *Surg Laparosc Endosc* 1999;9(1):60-62
- Kluin J, den Hoed PT, van Linschoten R, Ijzerman JC, van Steensel CJ. Endoscopic evaluation and treatment of groin pain in the athlete. *Am J Sports Med* 2004;32:944-949
- Kulah B, Duzgun AP, Moran M, Kulancoglu IH, Ozmen MM, Coskun F. Emergency hernia repairs in elderly patients. *Am J Surg* 2001;182(5):455-459
- Kulah B, Kulacoglu IH, Oruc MT, Duzgun AP, Moran M, Ozmen MM, Coskun F. Presentation and outcome of incarcerated external hernias in adults. *Am J Surg* 2001;181(2):101-104
- Kumar A, Doran J, Batt ME, Nguyen Van Tam JS, Beckingham JJ. Results of inguinal canal repair in athletes with sports hernia. *J R Coll Surg Edinb* 2002;47(3):561-565
- Kux M, Fuchsjaeger N, Schemper M. Shouldice is superior to Bassini inguinal herniorrhaphy. *Am J Surg* 1994;168(1):15-18
- Kux M. Anatomy of the groin: a view from the surgeon. In: Fitzgibbons RJ Jr, Greenburg GA, eds. *Nyhus and Condon's Hernia*. 5th edition Philadelphia: Lippincott, 2002: 45-53
- Lacroix VJ, Kinnear DG, Mulder DS, Brown RA. Lower abdominal pain syndrome in national hockey league players: a report of 11 cases. *Clin J Sport Med* 1998;8:5
- Lacroix VJ. A complete approach to groin pain. In: *The Physician and Sportsmedicine Vol 28*; McGraw Hill New York 2000:66-86
- Lange B, Langer C, Markus PM, Becker H. Paralysis of the femoral nerve following totally extraperitoneal laparoscopic inguinal hernia repair. *Surg Endosc* 2003;17(7):1157
- Lantis JC, Schwaitzberg SD. Tack entrapment of the ilioinguinal nerve during laparoscopic hernia repair. *J Laparoendosc Adv Surg Tech A* 1999;9(3):285-289
- Lau H, Patil NG. Impact of previous appendectomy on the outcomes of endoscopic totally extraperitoneal inguinal hernioplasty. *Surg Laparosc Endosc Percutan Tech* 2004;14(59):257-259
- LeBlanc KE, LeBlanc KA. Groin pain in athletes. *Br J Sports Med* 1999;33(1):52-53
- Lehmann LJ, Lewis MC, Goldman H, Marshall JR. Cardiopulmonary complications during laparoscopy: two case reports. *South Med J* 1995;88(10):1072-1075
- Leveille SG, Gray S, LaCroix AZ, Ferruci L, Black DJ, Guralnik JM. Physical inactivity and smoking increase risk for serious infections in older women. *J Am Geriatr Soc* 2000;48(12):1582-1588
- Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. The tension-free hernioplasty. *Am J Surg* 1989;157:188-193
- Lichtenstein IL, Shulman AG, Amid PK. The cause, prevention, and treatment of recurrent groin hernia. *Surg Clin North Am* 1993;73(2):529-544
- Liem MS, van der Graaf Y, Zwart RC, Geurts I, van Vroonhoven TJ. Risk factors for inguinal hernia in women: a case-control study. The COALA Trial Group. *Am J Epidemiol* 1997;146(9):721-726
- Lienhart A, Pequignot F, Auroy Y, Benhamou D, Clergue F, Laxenaire MC, Jouglé E. Factors associated with laparoscopic approach for cholecystectomy, appendectomy and inguinal herniorrhaphy in France. *Ann Fr Anesth Reanim* 2003;22(9):778-786
- Lindenfeld TN et al. Incidence of injury in indoor soccer. *Am J Sports Med* 1994;22:364-371
- Lodding P, Bergdahl C, Nyberg M, Pileblad E, Stranne J, Hugosson J. Inguinal hernia after radical retropubic prostatectomy for prostate cancer: a study of incidence and risk factors in comparison to no operation and lymphadenectomy. *J Urol* 2001;166(3):964-967
- Losanoff J, Richman BW, Jones JW. Parapubic hernia: case report and review of the literature. *Hernia* 2002;6(29):82-85
- Losanoff J, Richman BW, Jones JW. Handlebar hernia: ultrasonography-aided diagnosis. *Hernia* 2002;6(1):36-38
- Lovell G. The diagnosis of chronic pain in athletes: a review of 189 cases. *Aust J Sci Med Sport* 1995;27(3):76-79
- Luijendijk RW, de Lange DC, Wauters CC, Hop WC, Duron JJ, Pailler JL, Camprodon BR, Holmdahl L, van Geldorp HJ, Jeckel J. Foreign material in postoperative adhesions. *Ann Surg* 1996;223(3):242-248
- Lynch SA, Renström PAFH. Groin injuries in sport: treatment strategies. *Sports Medicine* 1999;28(2):137-144
- Macarthur DC, Grieve DC, Thompson AM, Greig JD, Nixon SJ. Herniography for groin pain of uncertain origin. *Br J Surg* 1997;25:402-408
- Madan AK, Likes M, Raafat A. Pneumomediastinum as a complication of preperitoneal laparoscopic herniorrhaphy. *JSLs* 2003;7(1):73-75
- Mahajna A, Ofer A, Krausz MM. Traumatic abdominal hernia associated with large bowel strangulation: case report and review of the literature. *Hernia* 2004;8(1):80-82
- Makinen MT, Yli-Hankala A. Respiratory compliance during laparoscopic hiatal and inguinal hernia repair. *Can J Anesth* 1998;45(9):865-870
- Malangoni MA, Condon RE. Traumatic abdominal wall hernia. *J Trauma* 1983;23:356-357
- Malangoni MA, Gagliardi RJ. Hernias. In: Townsend, Beachamp, Evers, Mattox (eds.) *Sabiston Textbook of Surgery* 17th edition 2004 Elsevier Saunders Publishers: 1199-1218
- Malazgirt Z, Ozen N, Ozkan K. Effect of appendectomy on development of right inguinal hernia. *Eur J Surg* 1992;158(1):43-44
- Malycha P, Lovell G. Inguinal surgery in athletes with chronic groin pain: the sportsman's hernia. *Aust N Z J Surg* 1992; 62(2):123-125
- McKenney MG, Fietsam R, Glover JL, Villalba M. Spermatic cord hematoma: case report and literature review. *Am Surg* 1996;62(9):768-9
- McVay CB. The normal and pathologic anatomy of the transversus abdominis muscle in inguinal and femoral hernia. *Surg Clin North Am* 1971;51:1251-1261
- Memom MA, Cooper NJ, Memom B, Memom MI, Abrams KR. Meta-analysis of randomized clinical trials comparing open and laparoscopic inguinal hernia repair. *Br J Surg* 2003;90(12):1479-92
- Metzdorff MT, Miller SH, Smiley P, Klabacha ME. Blunt traumatic rupture of the abdominal wall musculature. *Ann Plast Surg* 1984;13:63-66
- Mhoon JM, Redman JF, Siebert JJ. Scrotal enlargement in boys with a history of scrotal trauma: two unusual findings. *South Med J* 2002;95(2):251-252
- Mikkelsen T, Bay-Nielsen M, Kehlet H. Risk of femoral hernia after inguinal herniorrhaphy. *Br J Surg* 2002;89(4):486-488
- Miller K. Occupational health injuries: a brief review of three disorders. *Nurs Clin North Am* 2004;39(2):395-402
- Millikan JS, Moore EE, van Way CW, Kelly GL. Vascular trauma in the groin: contrast between iliac and femoral injuries. *Am J Surg* 1981;142(6):695-698
- Moeller JL. Contraindications to athletic participation: spinal, systemic, dermatologic, paired-organ, and other tissues. *Physician and Sportsmedicine* 1996;24(9):
- Montes IS, Deysine M. Spigelian and other uncommon hernia repairs. *Surg Clin North Am* 2003;83:1235-1253
- Moorman ML, Price PD. Migrating mesh plug: complication of a well-established hernia repair technique. *Am Surg* 2004;70(4):298-299
- Morelli V, Smith V. Groin injuries in athletes. *Am Fam Physician* 2001;64:1405-14

- Moskovitz WS. Traumatic inguinal hernia and thrombosis of the external iliac artery due to blunt trauma. *Hawaii Med J* 1961;20:336
- Mucciolo RL, Godec CJ. Traumatic acute incarcerated scrotal hernia. *J Trauma* 1988;28(5):715-716
- Musella M, Milone F, Chello M, Angelini P, Jovino R. Magnetic resonance imaging and abdominal wall hernias in aortic surgery. *J Am Coll Surg* 2001;193(4):392-395
- Nehme AE. Groin hernias in elderly patients. Management and prognosis. *Am J Surg* 1983;146(2):257-260
- Neumayer L, Giobbie-Hurder A, Jonasson O, Fitzgibbons R, Dunlop D, Gibbs J, Reda D, Henderson W, Veterans Affairs Cooperative Studies Program 456 Investigators. Open mesh versus laparoscopic mesh repair of inguinal hernia. *N Engl J Med* 2004;350(18):1819-27
- Nicholas SJ, Tyler TF. Adductor muscle strains in sport. *Sports Medicine* 2002;32(5):339-344
- Nordin P, Haapaniemi S, van der Linden W, Nilsson E. Choice of anesthesia and risk for recurrence in groin hernia repair. *Ann Surg* 2004;240(1):187-192
- Nussbaumer P, Weber D, Hollinger A. Traumatic perforation of the small intestine – a rare complication of inguinal hernia. *Schweiz Rundsch Med Prax* 2000;89(21):934-6
- Nyhus LM, Klein MS, Rogers FB. Inguinal hernia. *Curr Probl Surg* 1991;28(6):401-50
- Nyhus LM. Individualization of hernia repair: a new era. *Surgery* 1993;114(1):1-2
- Nyhus LM. Iliopubic tract repair of inguinal and femoral hernia. The posterior preperitoneal approach. *Surg Clin North Am* 1993;73(3):487-499
- Oishi SN, Page CP, Schwesinger WH. Complicated presentations of groin hernias. *Am J Surg* 1991;162(6):568-570
- O’Kane JW. Anterior hip pain. *Am Fam Phys* 1999;60:1687-96
- Oncel M, Kurt N, Eser M, Bahadır I. Small bowel perforation due to blunt trauma directly to the inguinal region: a case report. *Hernia* 2003;7(4):218-219
- Orchard J, Read J, Neophyton J, Garlick D. Ultrasound findings of inguinal canal posterior wall deficiency associated with groin pain in footballers. *Br J Sports Med* 1998;32(2):134-139
- Orchard J, Read J, Verrall G, Slavotinek J. Pathophysiology of chronic groin pain in the athlete. *Int J Sports Med* 2000;1(1).
- Orchard J. Management of muscle and tendon injuries in footballers. *Au Fam Phys* 2003;7:489-493
- Otero C, Fallon WF. Injury to the abdominal wall musculature: the full spectrum of traumatic hernia. *South Med J* 1988;81:517-520
- Ovroutski S, Ewert P, Schubel J, Lange PE, Hetzer R. A rare complication of laparoscopic surgery: iatrogenic arteriovenous fistula with high-output cardiac failure. *Surg Laparosc Endosc Percutan tech* 2001;11(5):334-337
- Paajanen H, Syvahuoko I, Airo I. Total extraperitoneal endoscopic (TEP) treatment of sportsman’s hernia. *Surg Laparosc Endosc Percutan Tech* 2004;14(4):215-8
- Parker J, Hayes C, Wong F, Carter J. Laparoscopic ilioinguinal nerve injury. *Gynaecological Endoscopy* 1998;7(6):327
- Perez VM, McDonald AD, Ghani A, Bleacher JH. Handlebar hernia: a rare traumatic abdominal wall hernia. *J Trauma* 1998;44:568
- Petros JG, Rimm EB, Robillard RJ, Argy O. Factors influencing postoperative urinary retention in patients undergoing elective inguinal herniorrhaphy. *Am J Surg* 1991;161(4):431-433
- Pleumeekers HJ, De Gruijl A, Hofman A, Van Beek AJ, Hoes AW. Prevalence of aortic aneurysm in men with a history of inguinal hernia repair. *Br J Surg* 1999;86(9):1155-1158
- Poglase AL, Frydman GM, Farmer KC. Inguinal surgery for debilitating chronic groin pain in athletes. *Med J Aust* 1991;155:674-677
- Putukian M, Knowles WK, Swere S, Castle NG. Injuries in indoor soccer. The Lake Placid Dawn to dark soccer tournament. *Am J Sports Med* 1996;24:317-322
- Rai S, Chandra SS, Smile SR. A study of the risk of strangulation and obstruction in groin hernias. *Aust N Z J Surg* 1998;68(9):650-654
- Read RC, McLeod PC. Influence of a relaxing incision on suture tension in hernia repairs. *Arch Surg* 1981;116:440-445
- Reijnen MM, Bleichrodt RP, van Goor H. Pathophysiology of intra-abdominal adhesion and abscess formation, and the effect of hyaluronan. *Br J Surg* 2003;90(5):533-541
- Renstrom P, Peterson L. Groin injuries in athletes. *Br J Sports Med* 1980;14:30-6
- Reynolds RD. Intestinal perforation from trauma to an inguinal hernia. *Arch Fam Med* 1995;4(11):972-974
- Rink J, Ali A. Intestinal obstruction after totally extraperitoneal laparoscopic inguinal hernia repair. *JLS* 2004;8(1):89-92
- Robinson P. Ultrasound in groin injury. *Imaging* 2002;14:209-216
- Roos HP. Hip pain in sport. *Sports Med Arthroscopy Rev* 1997;5:292-300
- Rorbaek-Madsen M. Herniorrhaphy in patients aged 80 years or more. A prospective analysis of morbidity and mortality. *Eur J Surg* 1992;158(11-12):591-594
- Ruane JJ, Rossi TA. When groin pain is more than just a strain: navigating a broad differential. *Physician and Sportsmedicine* 1998;26(4):
- Rupp TJ, Purcell C, Karageanes S. Groin injury <http://www.emedicine.com/sports/topic162.htm> September 15 2004
- Rutkow IM, Robbins AW. Demographic, classificatory, and socioeconomic aspects of hernia repair in the United States. *Surg Clin North Am* 1993;73(3):413-426
- Rutkow IM, Robbins AW. Tension-free inguinal herniorrhaphy: a preliminary report on the mesh-plug technique. *Surgery* 1993;114(1):3-8
- Rutkow IM, Robbins AW. Classification of groin hernias. In: Bendavid R, editor. *Prostheses and abdominal wall hernias*. Austin (TX): RG Landes 1994
- Rutkow IM, Robbins AW. Classification systems and groin hernias. *Surg Clin North Am* 1998;78(6):1117-1127
- Rutkow IM. Demographic and socioeconomic aspects of hernia repair in the United States in 2003. *Surg Clin North Am* 2003;83:1045-1051
- Salcedo-Wasicek MC, Thirlby RC. Postoperative course after inguinal herniorrhaphy. A case-controlled comparison of patients receiving workers’ compensation vs patients with commercial insurance. *Arch Surg* 1995;130(1):29-32
- Schaap HM, van de Pavoordt HD, Bast TJ. The preperitoneal approach in the repair of recurrent inguinal hernias. *Surg Gynecol Obstet* 1992;174(6):460-464
- Schäfer M, Lauper M, Krähenbühl L. Trocar and Veress needle injuries during laparoscopy. *Surg Endosc* 2001;15(3):275-280
- Schmitz R, Schmitz N, Treckmann J, Shah S. Long-term results after tension-free inguinal hernia repair. *Chirurg* 1999;70(9):1014-1019
- Schumpelick V, Treutner K, Arlt G. Inguinal hernia repair in adults. *Lancet* 1994;344:375-379
- Schumpelick V, Arlt G. In: *Problems in general surgery*. Philadelphia: Lippincott-Raven Publications; 1995:57-58
- Schumpelick V. *Hernien*. Thieme Stuttgart 2000: 323-339
- Scott NW, McCormack K, Graham P, Go PM, Ross SJ, Grant AM. Open mesh versus non-mesh of femoral and inguinal hernia. *Cochrane Database Syst Rev* 2002;(4):CD002197

- Shouldice EE. The treatment of hernia. *Ontario Med Rev* 1953;20:670-684
- Shouldice EB. The Shouldice repair for groin hernias. *Surg Clin North Am* 2003;83:1163-1187
- Simchen E, Rozin R, Wax Y. The Israeli study of surgical infections of drains and the risk of wound infection in operation for hernia. *Surg Gynecol Obstet* 1990;170(4):331-337
- Simonet WT, Saylor HL, Sim L. Abdominal wall muscle tears in hockey players. *Int J Sports Med* 1995;16(2):126-128
- Sippo WC, Gomez AC. Nerve-entrapment syndromes from lower abdominal surgery. *J Fam Pract* 1987;25(6):585-587
- Skandalakis J, Gray S, Skandalakis L. Surgical anatomy of the inguinal area. *World J Surg* 1989;13:490-498
- Skandalakis J, Colborn G, Androulakis J, Skandalakis L, Pemberton L. Embryologic and anatomic basis of inguinal herniorrhaphy. *Surg Clin North Am* 1993;73(4):799-836
- Sorensen LT, Friis E, Jorgensen T, Vennits B, Andersen BR, Rasmussen GI, Kjaergaard J. Smoking is a risk factor for recurrence of groin hernia. *World J Surg* 2002;26(4):397-400
- Stoppa R. Hernias of the abdominal wall. In: Chevrel JP, editor. *Hernias and surgery of the abdominal wall*. Springer, Berlin 1998:171-277
- Stulz P, Pfeiffer KM. Peripheral nerve injuries resulting from common surgical procedures in the lower portion of the abdomen. Stulz P, Pfeiffer KM. *Arch Surg* 1982;117(39):324-327
- Susmallian S, Ezri T, Elis M, Warters R, Charuzi I, Muggia-Sullam M. Laparoscopic repair of sportsman's hernia in soccer players as treatment of chronic inguinal pain. *Med Sci Monit* 2004;10(2):CR52-54
- Swain R, Snodgrass S. Managing groin pain: even when the cause is not obvious. *Phys Sportsmed* 1995;23(11):55-66
- Szymanski J, Voitk A. Laparoscopic repair of inguinal hernias with a higher risk for recurrence: independent assessment of results from 121 repairs. *Am Surg* 2001;67(2):155-158
- Taylor DC, Meyers WC, Moylan JA, Lohnes J, Bassett FH, Garrett WE. Abdominal musculature abnormalities as a cause of groin pain in athletes. Inguinal hernias and pubalgia. *Am J Sports Med* 1991;19:239-42
- Taylor SG, O'Dwyer PJ. Chronic groin sepsis following tension-free inguinal hernioplasty. *Br J Surg* 1999;86(4):562-565
- Thomas SM, Barnes JP. Recurrent inguinal hernia in relation to ideal body weight. *Surg Gynecol Obstet* 1990;170(6):510-512
- Thomas RH and Thomas GO. Painful incarcerated hernia following a rugby union lineout *Br J Sports Med* 1999;33(1):52-53,
- Tobin GR, Clark S, Peacock EE. A neuromuscular basis for the development of indirect inguinal hernia. *Arch Surg* 1976;111(4):464-466
- Tucker JB, Marron JT. The qualification/disqualification process in athletics. *Am Fam Physician* 1984;29(2):149-154
- Uppot RN, Gheyi VK, Gupta R, Gould SW. Intestinal perforation from blunt trauma to an inguinal hernia. *AJR* 2000;174:1538
- Urquart DS, Packer GJ, McLatchie GR. Return to sport and patient satisfaction levels after surgical treatment for groin disruption. *Sports Exercise and Injury* 1996;2:37-42
- Van der Donck K, Steenbrugge F, van den Abbeele K, Verdonk R, Verhelst M. Baissin's hernia repair and adductor longus tenotomy in the treatment of chronic pain in athletes. *Acta Orthop Belg* 2003;69(1):35-41
- Vasquez JC, Halasz NA, Chiu P. Traumatic abdominal wall hernia caused by persistent cough. *South Med J* 1999;92(9):907-908
- Vecchio R, Di Martino M, Lipari G, Sambataro L. Previous appendicitis may affect peritoneal overlap of mesh in laparoscopic inguinal hernia repair. *Surg Endosc* 2002;16(2):359
- Verrall G, Slavotinek J, Fon G. Incidence of pubic bone marrow oedema in Australian rules football players: relation to groin pain. *Br J Sports Med* 2001;35:28-33
- Vijay V, Bebawi MA, Godfrey HG. Groin lymphocele following blunt trauma. *Injury* 1995;26(7):500-501
- Voyles CR, Hamilton BJ, Johnson WD, Kano N. Meta-analysis of laparoscopic inguinal hernia trials favors open hernia repair with preperitoneal mesh prosthesis. *Am J Surg* 2002;184(1):6-10
- Wantz GE. Complications of inguinal hernia repair. *Surg Clin North Am* 1984;64(2):287-298
- Westlin N. Groin pain in athletes from Southern Sweden. *Sports Med Arthroscopy Rev* 1997;5:280-4
- Williams P, Foster ME. Gilmore's groin – or is it? *Br J Sports Med* 1995;29:206-208
- Wood RJ, Ney A, Bubrick MP. Traumatic abdominal hernia: a case report and review of the literature. *Am Surg* 1988;54:648-651
- Yilmazlar T, Kizil A, Zorluoglu A, Ozguc H. The value of herniography in football players with obscure groin pain. *Acta Chir Belg* 1996;96:115-8
- Young CC. Extreme sports: injuries and medical coverage. *Curr Science* 2002;1:305-311
- Zhao C, Amadio PC, Momose T, Couvreur P, Zobitz ME, An KN. The effect of suture technique on adhesion formation after flexor tendon repair for partial lacerations in a canine model. *J Trauma* 2001;51(59):917-921
- Zib M, Gani J. Inguinal hernia repair: where to next? *ANZ J Surg* 2002;72(8):573-579
- Zimmerman LM. Pitfalls in the management of inguinal hernias. *Surg Clin North Am* 1958;38(1):189-195
- Zimmerman G. Groin pain in athletes. *Aust Fam Physician* 1988;17(12):1046-52
- Ziprin P, Williams P, Foster E. External oblique aponeurosis nerve entrapment as a cause of groin pain in the athlete. *Br J Surg* 1999;86(4):566-568
- Zollinger RM. Classification systems for groin hernias. *Surg Clin North Am* 2003;83:1053-1063

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