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3.1 History

The term hernia defines the exit of an organ through the wall of the cavity in which it normally resides, either through an existing or a newly formed orifice.

It is widely used inside the surgical community since it refers to one of the most frequent diseases encountered in daily practice. Nevertheless its etymological origin is still controversial. According to some the term originated from the ancient Greek word *ernos*, which means “branch” or “sucker” given due to its similarity to an abdominal wall germination, while others claim a Latin etymological root from the word *hira*, which means “bowel.”

A hernia is one of the oldest recorded afflictions of mankind since numerous references have been already reported in Assyro-Babylonian and Egyptian manuscripts and it is fascinating to observe how, over the centuries [1], the improvement in hernia treatment has gone hand in hand with the cultural evolution of the human race.

The oldest preserved documents in medical science, the Papyrus of Ebers, written during the reign of Amenhotep I (ca 1552 A.D.) but probably dating back to the First Dynasty (ca 3000 A.D.), describes patients suffering from an inguinal hernia and its relationship to coughing [2].

Although, the interpretation of the ancient Egyptian texts is complex and leaves some doubts about the suggested treatment of inguinal hernia. It's still unclear if the heat applied on the groin hernia is recommended to reduce the hernia content or to cauterize, achieving a closure of the hernia defect by scar tissue production.

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However, studies on the mummified remains of the pharaohs Merneptah (ca 1215 A.D.) and Ramses V (ca 1157 A.D.) suggest that both were likely treated for an inguinal hernia aggressively [1].

Later, during the Hellenistic period, numerous treatises testify a deep awareness to hernia pathology. The disciples of Hippocrates argued the rupture of the peritoneum with the stretching of the overlying fascia and muscular tissues as the origin of abdominal hernias.

In *De Medicina*, the roman encyclopedic writer Cornelio Celso (30–50 A.D.) described an advanced surgical treatment in sedated patients, with hemostatic vascular ligation, hernial sac closure, and preservation of the testis [3].

Anyway, this refined culture was lost during the Middle Ages, ruled by the principle of *Ecclesia abhorret a sanguine*. At that time, many surgeons were reluctant to perform surgery and castration was the most common practice.

Renaissance surgeons dare more than their predecessors, benefiting from the dawn of printing with the first monographies in treatment of herniation, as *Traité des hernies* by Pierre Franco (1500–1561) favored the knowledge and improved their skill all over the Europe [4].

A resumption of the surgical approach was summarized in the work of Ambroise Pare (1510–1590), who acquired the lesson providing an innovative surgical technique: the Golden Thread [5].

Through a groin incision, the hernial sac was loosened from testicular vessels and cremaster muscle and closed with several golden transfixed stitches (*Point doré*) and then sutured at the wound edges.

But only in the nineteenth century, a milestone on hernia surgery has been pursued by an Italian surgeon, Edoardo Bassini (1844–1924), who first asserted the strategic role of the posterior inguinal wall in hernia recurrence [6]. Thanks to an improved knowledge in anatomy, anesthesia, and antisepsis, he performed an innovative technique, suturing the conjoined tendon to the inguinal ligament and conferring a strong reinforcement to the inguinal wall. The astonishing results in terms of recurrence and infection paved the way to contemporary hernia surgery.

3.2 Etiology

Beyond the fascinating historical aspects, passing time has also played a key role on the abdominal hernias.

The natural evolution of the terrestrial mammals can be considered the oldest etiological factor in hernia onset. Assuming the erect station they exposed the weakest parts of their body to the negative effects of gravity. In addition to phylogeny, even ontogeny may be involved in some abdominal hernia onset. During the fetal life, some physiological functions may negatively impact on structural strength of the abdomen. The umbilical cord for fetal nutrition and the peritoneal vaginal duct for the descent of the testicle into the scrotum in the inguinal canal are weak areas

which usually undergo obliteration after delivery, but an inadequate closure, when engaged by viscera, inevitably leads to a congenital hernia.

Although congenital hernias are typical of childhood, acquired hernias are mainly observed in adults, as an inevitable consequence of the wear and tear of living. Its onset is influenced by favoring and triggering factors, which act simultaneously [7].

Predisposing factors may be divided into acquired (ageing, tobacco smoke, nutritional disorders as lathyrism, surgical scars) or congenital (collagenosis as Marfan and Ehlers-Danlos syndromes), justifying the higher incidence of abdominal hernia in certain familiar lines. They are both able to alter the collagen quality, which normally confers mechanical resistance to the biological tissue.

Trigger factors as pregnancy, chronic obstructive pulmonary disease, prostatic hypertrophy, ascites, obesity, chronic constipation or traumatic events, increasing intra-abdominal pressure for a long time expose the weaker part of the abdominal wall to a chronic mechanical stress. Following the principle of Laplace law, which states that mechanical wall stress is equal to wall tension divided by wall thickness, thin areas, as abdominal midline (linea alba) or inguinal canal, are more prone to a structural failure and hernia onset.

3.3 Epidemiological and Social Aspects

Epidemiological and economical researches attribute to abdominal hernias the definition of social problem. Even if we don't know exactly the scale of the problem worldwide, the prevalence of this pathology in the USA, referred to a population of people who are managing abdominal hernia at any given time, is estimated at 1:60 people, while incidence, referred to the annual diagnosis rate or the number of new cases of an abdominal hernia diagnosed each year, shows a rate of 1:339 people, which corresponds by extrapolations to 800.000 new cases per year, 66.666 per month, equal to 1 per minute!

The projections quoted are confirmed by statistical data, reporting inguinal hernia repair as one of the most common operations performed in general surgery, with rates ranging from 10:100.000 people in the UK to 28:100.000 in the USA [8].

Some factors as age, lifestyle, and gender can influence negatively the incidence, even if in different manners. For example, in inguinal hernia the age of distribution shows a bimodal trend, peaking at early childhood and subsequently in old age (Table 3.1), while the abdominal hernias show a peak between 3rd and 6th decades, with the highest incidence in multipara females (38%).

Lifestyle may impact only slightly on hernia onset, appearing more evident on hernia recurrences and surgical site infections.

Undoubtedly hernia onset can be influenced by gender, with a lifetime risk of 27% for men and 3% for women with a higher incidence of an inguinal hernia in male (ratio of 7–9:1) (Table 3.2) and a higher incidence of an abdominal hernia in female (ratio of 2:1) [9].

Table 3.1 Age and inguinal hernia repair

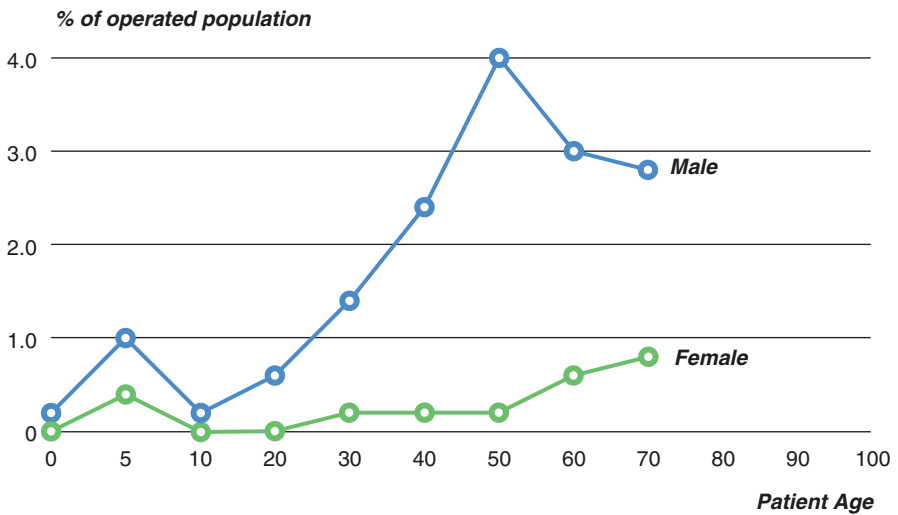
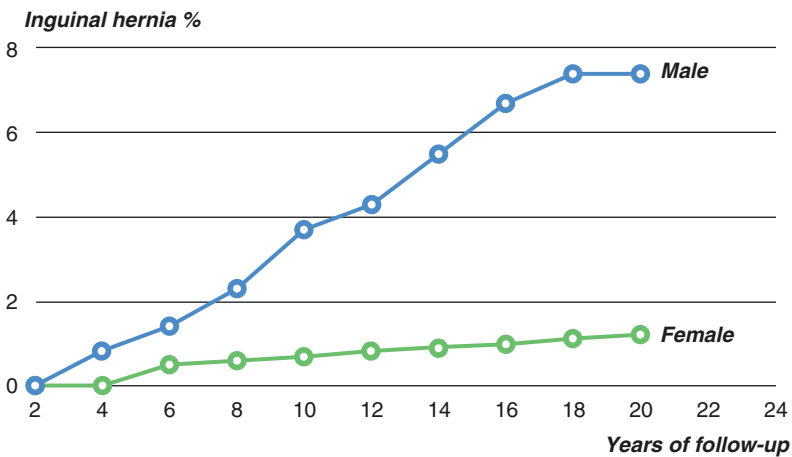


Table 3.2 Cumulative probability of inguinal hernia by sex among adults in the USA



The commitment of human and economic resources involved in hernia care must be assessed not only for surgical activity but extended to health care and social management too.

During the period 2002–2003, in England, hospital consultant episodes were related in 0.67% to an inguinal hernia and in 0.005% to an unspecified abdominal hernia, followed by emergency hospital admission, respectively, in 8% of cases and

in 36% of cases, with a mean length of stay in hospital of 2.4 days for an inguinal hernia and 7.7 days for an unspecified abdominal hernia, which required more than 100,000 hospital bed days/year [10].

The extreme variability of clinical forms in which this disease occurs, patients are managed clinically through different care settings, depending on the extent of the disease treated.

Much of the inguinal and the abdominal wall primary pathology is treated as out-patient, providing effective performance at low cost. Fragile patients or patients with severe co-morbidities and major pathological forms require an in-patient setting, with prolonged hospital stays and high costs to the health system.

The social impact may be also guessed by statistic reports, measuring disability and loss of working days per year. In a seminal 1890 publication on his technique, Edoardo Bassini recommended 6 weeks of bed rest followed by an extended period of convalescence [11].

This advice remained the standard of care throughout the forties. Only starting from the sixties, the surgeons led to early mobilization and return to activity immediately after surgery, even after major abdominal surgery [12, 13].

However, because recurrence is a frequent issue after operation, the practice of recommending extended convalescence has persisted long-lasting, despite the research demonstrates that early return to activity has no detrimental effect [14, 15].

Recently, a case-control study performed in Denmark on convalescence, after Lichtenstein procedure defined the gold standard technique in inguinal hernia repair, reported a median length of absence from work of 7 days (4.5 days for sedentary work and 14 days for heavy work), with the pain as the most common cause of delay (60%), followed by wound complications (20%) [8].

The number of days of work lost for hernia pathologies is higher than for any other chronic digestive condition [16]. With a statistical prediction of more than 20 million of surgical procedures performed each year worldwide, it is possible to calculate a 140 million of loss in working days per year, only for inguinal hernia.

3.4 Classification

By a clinical point of view, inguinal and other abdominal hernias can be considered a cluster of pathologies since they are assimilated by nosological and clinical aspects.

Different systems to classify abdominal and inguinal hernia have been proposed over the times, sometimes using more than one, to define better the clinical aspect.

Classifications play important roles in organization and management of the knowledge. They are a useful tool to identify anatomical landmark, plan surgery, and evaluate results in terms of recurrence or postoperative quality of life, degree of disability, and time of convalescence. Through these instruments can be prepared consistent follow-up and statistic studies.

One of the most used classifications is on ontogenic basis, distinguishing between congenital and acquired hernia, when the onset is at or after the birth, as mentioned

before. Sometimes it is used as pathogenetic criterion, distinguishing primary, with a spontaneous onset, from secondary hernia following a previous surgical treatment, called also recurrent or incisional hernia.

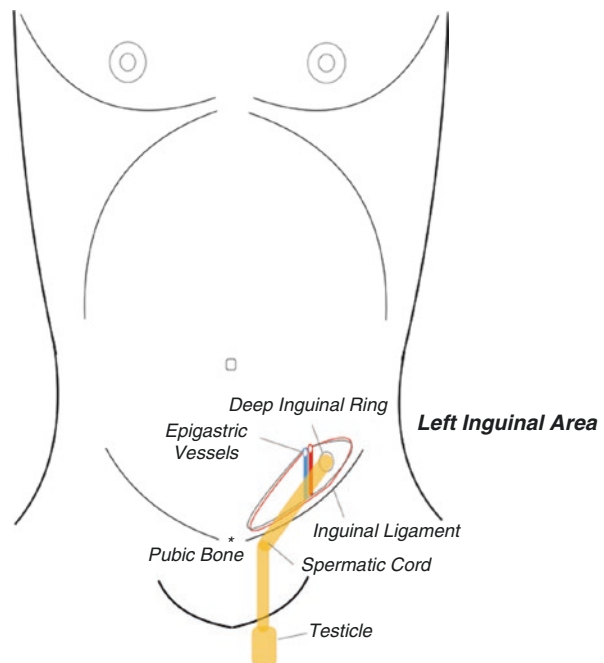
The reference to the anatomical site is another effective method to classify hernias in daily practice, describing inguinal, femoral, epigastric, umbilical, lumbar, diaphragmatic, or perineal hernia.

In 2007 the European Hernia Society [17] proposed a new systematic classification of groin hernia, still appreciated for its simplicity and completeness. It collects together some primary parameters such as the anatomical district (inguinal or femoral), the site of onset referred to the epigastric vessels which divide the inguinal floor in a medial zone (M for medial hernia) and in a lateral zone (L for lateral hernia) (Pictures 3.1 and 3.2), the size of the defect (<1.5 cm, 1.5–3 cm, >3 cm), and its relation to recurrence with a primary hernia (P) or recurrent hernia (R). X indicates site not investigated by surgeon and 0 no hernia detected (Table 3.3).

Applying the same methodology, the European Hernia Society proposed also a new classification for abdominal wall defects which was simple, reproducible, and internationally accepted on a straight-line basis of topographical, dimensional, and clinical definition [18].

Taking into account the hernia site, the abdominal wall was divided into median (M1–M5) (Picture 3.3) and lateral defects (L1–L4) (Picture 3.4) with a cranio-caudal sectoralization.

Picture 3.1 Anatomy of inguinal area



Picture 3.2 Site of inguinal hernia

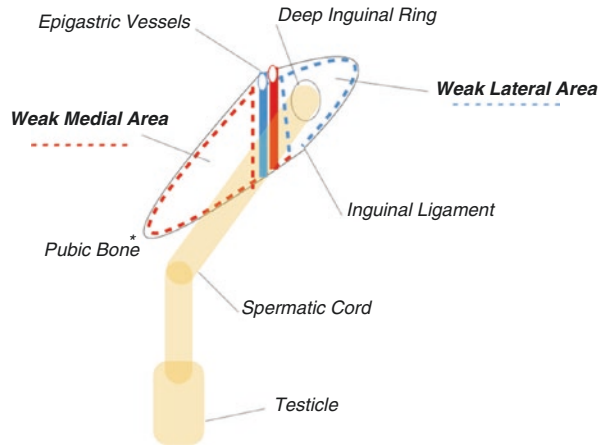


Table 3.3 Schematic European Hernia Society inguinal hernia classification

		P	R		
	0	1	2	3	X
L					
M					
F					

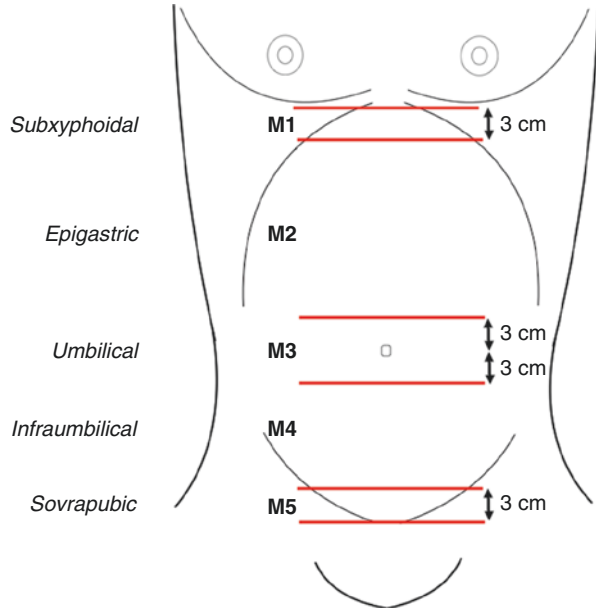
P: Primary Hernia
 R: Recurrent Hernia
 L : Lateral/Indirect Hernia
 M: Medial/Direct Hernia
 F : Femoral Hernia
 0: No Hernia Detectable
 1: < 1,5 cm
 2: < 3 cm
 3: > 3 cm
 X: Not Investigated

European Hernia Society, 2007

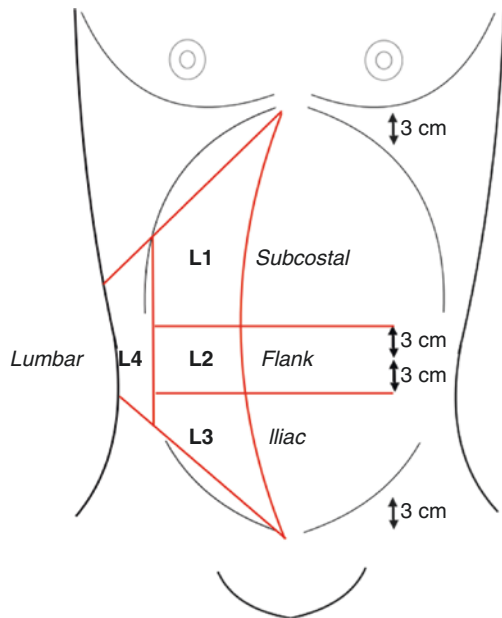
The size of hernia measured the width of the defect expressed in linear centimeters (W1 < 4 cm, W2 4–10 cm, W3 > 10 cm). It was considered the relation with recurrence, defining subgroups on the basis of the recurrence times ($R_0, R_1, R_2, \dots, R_n$).

This method of evaluation is undoubtedly a comprehensive model, but considered “static” since it doesn’t take into account two important parameters as patient, with his co-morbidities and wound classification, which may influence the final result.

Picture 3.3 Abdomen hernia site—midline. European Hernia Society classification

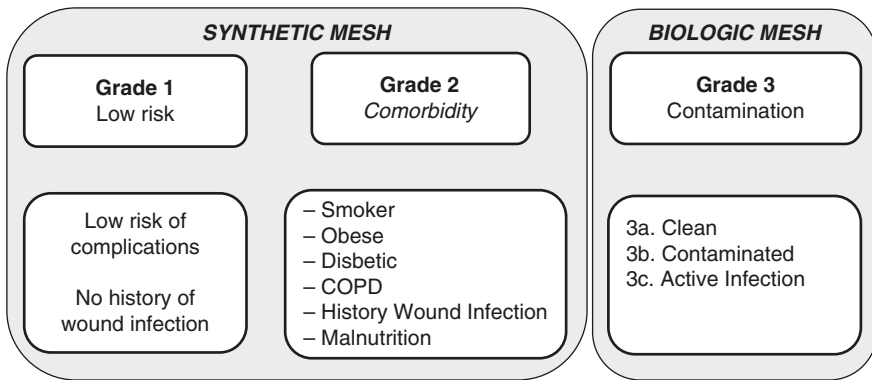


Picture 3.4 Abdomen hernia site—lateral. European Hernia Society classification



The Ventral Hernia Working Group [19], comprising expert surgeons, starting from the literature proposed a three grades classification, based on surgical field contamination and patient co-morbidities (Table 3.4).

The Grade One includes healthy patients and clean surgical field, the Grade Two patients with co-morbidities as diabetes, smoking, obesity, immunosuppression,

Table 3.4 Stratification of risk infection in mesh implantation

"The Ventral Hernia Working Group" Surgery 2010.148:544 - 558

and previous wound infection, and the Grade Three distinguished in subgroup a (clean-contaminated field), subgroup b (contaminated field), and subgroup c (active infection). They stated some clinical recommendations on perioperative optimization and surgical approach as the choice of the right mesh. Synthetic meshes are suitable for Class 1 and 2, while biologic or bio-like meshes are indicated for Class 3a and Class 3b. The Class 3c should be downgraded to Class 3b with the negative pressure wound therapy before to implant a non-synthetic mesh during the same period of hospitalization.

In the future we hope a new comprehensive classification which takes into account not only anatomical and dimensional but also clinical criteria, providing a platform for future investigations regarding technique, prosthetic choice, and perioperative optimization [20].

The diagnosis of inguinal and abdominal hernia is often made clinically and frequently associated with a visible bulging (Picture 3.5). However, a certain percentage of patients are asymptomatic and detected during the follow-up for other pathologies.

Pain is the most frequently observed symptomatology in the early stages of hernia pathology increasing after lifting heavy weight, abundant meals, or constipation.

Groin and abdominal hernia patients show some physical limitations in daily activity, while in huge abdominal hernia they usually experience social exclusion with limited ability to work and self-care may be substantially impaired in these patients (Picture 3.6).

In case of reducible hernia content without symptoms a watchful waiting may be a recommended strategy for groin hernia, while a surgical treatment should be planned in incisional hernia, symptomatic hernia, or when the content is not reducible.

Larger abdominal hernias are frequently associated with ischemic sufferance of the skin overlying the hernia sac and with chronic spinal complaints, due to an impairment of the lateral muscles of the abdomen.

Picture 3.5 Small left inguinal hernia



Picture 3.6 Giant inguinal hernia



In non-palpable mass a cough is requested to the patient, to facilitate the outflow of the viscera into the hernial sac, which will be easily evaluated by the exploring finger.

Sometimes in obese patients may be useful a radiological investigation to detect the unknown presence of the hernia. Sonography is a non-invasive method and may be helpful in good hands, but Tc scan gives much more information about the site of herniation, involved viscera, and dimensional evaluation of the defect. This enables to schedule a preoperative and surgical strategy, mandatory for huge abdominal hernia with loss of domain and convenient in most of incisional hernia.

Among the diagnostic investigations executed for inguinodynia, in the absence of clinical evidence of an inguinal hernia, the magnetic resonance may detect muscular impairment, aponeurotic tears, or an enthesopathy as cause of the symptomatic framework.

Picture 3.7 Giant ventral hernia (courtesy of Prof. P. Negro and Prof. F. Gossetti, Rome)



Strangulated hernia is a typical emergency hospital presentation with a non-reducible abdominal bulging associated with pain, vomiting, and constipation. It is estimated to affect 3% circa of inguinal and 6–15% of cases of abdominal hernia [21]. Presumably, the number of unreported cases is higher.

It requires an immediate surgical treatment with a complete debridement to avoid the ischemic consequences on the herniated viscera.

In more recent years, significant results in terms of survival, complications and recurrence rates have been achieved in patients affected by huge defects, (Picture 3.7) major co-morbidities, previous abdominal surgical procedures or open abdomen.

3.5 Surgery

Every year 20 million operations of inguinal hernia are performed worldwide and 350.000 and 100.000 ventral hernia procedures in the USA and Germany, respectively.

An important improvement in terms of recurrence rates after inguinal hernia repair has been achieved following the introduction of the meshes.

Also in terms of QOL, length of hospital stay, and postoperative pain, better outcomes have been reported when comparing mesh repair with standard tissue repair.

The majority of hernia surgeries can be performed in an out-patient setting with a classical open anterior mesh repair under local anesthesia. There are several surgical techniques using different mesh devices (Table 3.5). Among these, the Lichtenstein tension free mesh repair is still the most commonly performed. An open hernia repair under local anaesthesia (Table 3.6) lasts on average 45 min and the patient can be dismissed after the surgery, according to ambulatory care setting (Table 3.7).

Table 3.5 Type of meshes related to hernia site

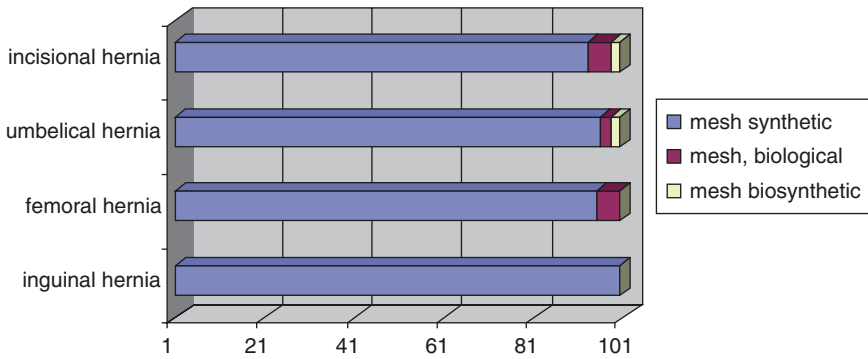


Table 3.6 Site of hernia and type of anesthesia performed

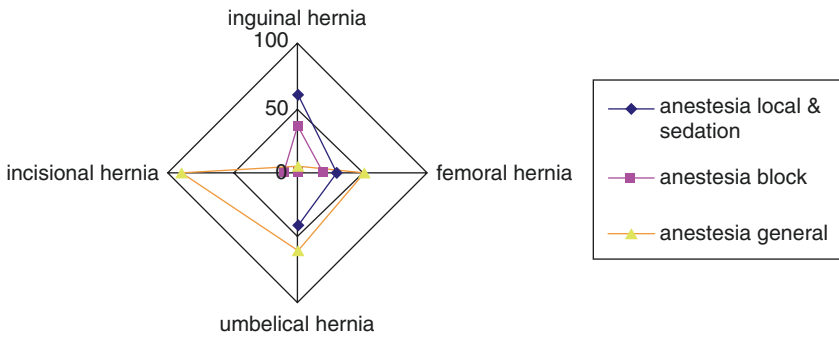
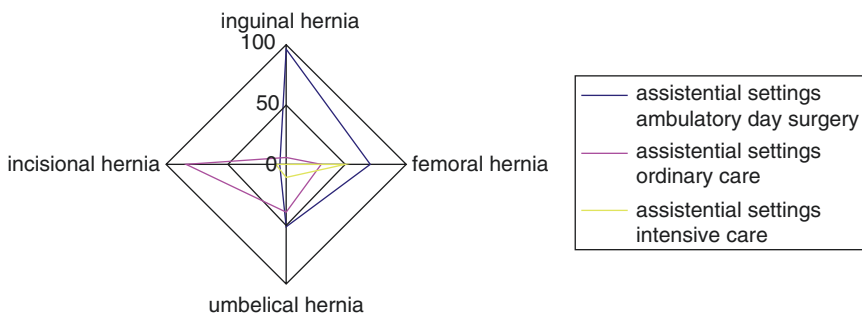


Table 3.7 Type of hernia and clinical settings



Minimally invasive approach for inguinal hernia repair was first introduced at the beginning of the 1990s. Totally extra-peritoneal (TEP) and transabdominal preperitoneal (TAPP) approaches are the two techniques used and the choice depends on the surgeon's preference. Operative time for a TAPP or a TEP procedure varies depending on the experience of the surgical team, the available technologies, the features of the clinical case and it could reach 1 h or more for complex recurrences.

All minimally invasive inguinal hernia repairs are done under general anesthesia, even it has been reported the feasibility of a TEP under spinal anesthesia.

The laparoscopic approach should be preferred to an open one in case of recurrent hernias because it allows avoiding the scar tissue of the previous repair. Bilateral hernia can be a good indication for laparoscopy as it permits the simultaneous treatment of both sides using the same trocar accesses, eliminating the need of a second incision.

Associated abdominal pathology is also considered an indication for the laparoscopic approach, allowing the concomitant minimally invasive treatment of both pathologies in the same session.

Recently, robotic approach has been used for inguinal hernia repair. However, longer operative times and increased costs with no evidence of better outcomes in terms of recurrence rate and hospital stay showed no superiority compared to the laparoscopic approach.

Ventral hernia can occur primarily or postoperatively. Meshes are widely used in ventral hernia repair and are associated with a lower rate of recurrence and better clinical outcomes.

The abdominal wall has to be considered as an organ and therefore its alterations are not only related with local symptoms, but may cause gastrointestinal, cardiovascular, respiratory, postural, and psychological dysfunctions.

Incisional hernia repair can vary widely according to the size and type of the defect. It can range from short procedures for small defects (<5 cm) to much more challenging and long-lasting procedures for complex abdomen requiring high technical skills and higher discomfort for the patient.

The laparoscopic approach can be indicated if the defects are not too large less than 6–7 cm, and mainly if the parietal tension is maintained, so only in case in which the surgeon does not have to reconstruct the abdominal wall.

Recently has been readopted the component separation technique (CST), that was firstly described by a plastic surgeon, Ramirez, in the late 1990s. It has been demonstrated that the CST could be the best option to treat the large and more complex defects of the abdominal wall, especially for the lateral and lumbar ones.

While a laparoscopic ventral hernia repair usually lasts approximately 1 h, for most complex cases approached with an open surgery with CST can be requested even 3 h or more, to 6–8 h.

The robotic technique for the treatment of huge ventral hernia can be considered a good option, as largely confirmed especially by most American surgeons. Nowadays the use of robot is most frequent in the abdominal wall repair than in the other pathologies. The robotic technique is cost and time dependent, but it has the

advantage to minimize the dissection of the tissue, reducing the bleeding, the risks of postoperative infections, and fluids collapse.

The length of hospital stay ranges from 1/2 day for laparoscopic procedures to a week or more for more complex clinical scenarios. Some complex ventral hernia requires an intensive care unit bed for the immediate postoperative time, where the patient is transferred intubated and then is awakened very slowly.

There are three kinds of prosthesis used for ventral hernia repair: synthetic, biological, and biosynthetic. Biological and biosynthetic are reabsorbable and act as a biological scaffold for tissue regrowth and are indicated in selected cases belonging to Group 2 and 3 according to Ventral Hernia Working Group Classification.

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