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# **Worst Case Scenarios! Complications Related to Hernial Disease**

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## **Abstract**

Incarceration, obstruction and strangulation are well recognized common complications of hernias. Several risk factors determine patients' morbidity and mortality. Hernia surgery complications encompass infections, fascial dehiscence, recurrence, neuralgia, visceral injury, and mesh erosion or migration predetermined by many risk factors. The types and criteria for surgical site infections are defined by the extent of the infection. Whether the open or laparoscopic approaches are attempted, the rates of the respective complications depend on the approach. Post-operative hernias are appreciated because of their prevalence and complications. The criteria for enhanced recovery after surgery depend on whether patient is in the pre-operative, intra-operative or post-operative phase. Within the pediatric population, the risk of developing umbilical and inguinal is variable.

**Keywords:** hernia, surgical complications, hernia surgery complications, recovery after hernia surgery, post-surgical complications, watchful waiting, recurrence, endoscopic approach, open approach

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## **1. Introduction**

Weakness or defects of the body wall, mainly the fibro-muscular tissue is known as hernia. The hernial disease is among the oldest diseases described in the medical literature with reports as old as 1500BC. It was not until the nineteenth century for the surgical approach to be recognized as a treatment modality when Bassini published novel approach and primary outcomes. Since

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then, the improvements in surgical approach emphasized intended to reduce the long-term hernia recurrence and complications. The use of synthetic material for support was introduced in the early 1900s by Handy by using silk for prosthetic support, but soon after it was found to increase the incidence of wound infection [1]. Risk factors for hernia include, but are not limited to, previous operations, physical stress, constipation, smoking, aging, trauma, family history, systemic disease, and obesity. Hernia repair is among the most common surgeries performed worldwide today, in which more than 75% found to be in the groin region, mainly inguinal canal hernias [2, 3]. The overall risk of developing hernia in a lifespan is around 15% in males and 5% in females, with proportionate increase in risk as the age increases. Inguinal hernias affect around 3–4% of the general population worldwide [4]. Differential diagnoses encompass any pathology that could lead to pain or mass formation in the groin area in particular. Such diagnoses include, but not limited to, soft tissue, lymphoid tissue, associated vessels, bony structures, and reproductive organs [5, 6]. Even though hernias, in general, are associated with overall promising short and long-term outcomes, there are still some complications to be recognized [7].

## **2. Complications of an untreated hernia**

### **2.1. Incarceration and strangulation**

Incarceration is the process by which hernia contents are trapped within a hernial sac in which reducing them is not possible. This result in decreased venous and lymphatic flow thus edema of incarcerated tissue. As a result, normal gut flora start flourishing and gas accumulates due to bacterial fermentation. As the swelling enlarges, the arterial blood flow to the hernial sac contents is compromised leading to ischemia and tissue necrosis, which is known as hernia strangulation [8]. These two entities are complications of hernia itself and are associated with increased rates of mortality and morbidity. The risk of incarceration and subsequent strangulation tend to be higher in the first few months to years and decrease with time. Gallegos et al. [9] estimated the probability of incarceration to be around 2.8% at 3 months and 4.8% at 2 years, which might be partially due to weakening of the abdominal wall and decreased pressure on the sac and its contents [9, 10]. Some of the risk factors for incarceration and subsequent strangulation include advanced age at the time of presentation, femoral hernia, and recurrent hernia [8]. Morbidity and mortality are determined by many factors including the patient age, comorbidities, and duration of the strangulation, the longer the duration, the greater the strangulation risk. For the reasons mentioned above along with an increased risk of perforation, a strangulated hernia is considered a surgical emergency that mandates surgical intervention with possible bowel resection. If the strangulation lasts longer than 4–6 hours on average bowel resection may be warranted. In such scenarios, placement of prosthetic mesh is usually not advised, as there will be a higher chance of bacterial translocation and wound infection [11, 12].

## **3. Complications of hernia surgery**

### **3.1. Surgical complications**

The incidence of complications associated with laparoscopic surgery is low on average when compared with an open approach. Most of the serious complications occur during access

to the abdominal cavity or while ports are created [13, 14]. Chandler et al. [15] reported the incidence of complications after laparoscopic surgery to be around 30 per 10,000, with half of the complications present in the first 24 hours post-surgery. Most common injuries were to the small bowel, iliac artery, and colon; while the least injured organs were the bladder and liver [15]. There is an increased risk of complications in patients with a history of previous abdominal surgery for any intra-abdominal pathology such as diverticulitis, history of extensive bowel resection, diaphragmatic hernia, and in patients with multiple cardiopulmonary risks [16].

### 3.2. Infection (wound, UTI, pneumonia)

Despite the fact that in the modern era advanced aseptic measures have decreased the incidence of post-operative infection; it is still a leading cause and a well-known complication of hernia surgery. Infections could be from multiple sources including the suture used and/or mesh. It is reported that infection incidences are as low as 1%, or even less, in multidisciplinary specialized hernia practice [17]. The most common underlying organisms are gram-positive skin flora. It was found that there is a slightly increased risk of infection with groin herniorrhaphy. Usually, it is hard to determine the extent of infection, whether skin and soft tissue are only involved, or deeper infection involving the mesh is there. Either way, should be treated with aggressive antibiotics and drainage, especially in the setting of a foreign body such as mesh [18].

From a broader perspective, surgical site infections are seen in around 1% of clean wounds and around 35% of contaminated wounds. **Table 1** lists different types of surgical wound infections. Clinical features include erythema, induration, warmth, and frothy discharge later in the course [19, 20]. The incidence of surgical wound infections can be reduced by following simple measures. For example, avoiding surgery in the setting of an active infection, antibiotic prophylaxis, proper skin preparation, maintaining sterile conditions throughout the surgery, and proper wound dressing [21].

### 3.3. Fascial dehiscence

Dehiscence is usually due to abdominal wall tension that exceeds the tissue and suture strength. It can be seen early in the post-operative period, and it could also happen as a late complication that might involve the full length of the surgical suture or part of it. Its incidence is estimated to be around 1–3% depending on the type of abdominal surgery. Despite of the improvement in the surgical techniques and wound management, the overall risk of fascial dehiscence remains unchanged [23–25].

Risk factors for wound dehiscence can be sub-classified into patient risk factors and those related to surgical site and surgeons' techniques. Patient risk factors include age, male gender, ascites, chronic pulmonary disease, post-operative cough, obesity, malnutrition, and chronic glucocorticoid therapy [19, 26]. Surgical technique risk factors include the length of the surgical wound if bigger than 18 cm or not. Suture failure is a major cause of fascial dehiscence, and it is said that in around 95% of cases knots are intact, but they have been pulled through the fascia resulting in fascial edge necrosis [27, 28].

Depth of infection	Comments
Superficial incisional	<p>Infection occurs within 30 days after the surgery and involves skin and subcutaneous tissue of the incision and encompasses the following criteria:</p> <ul style="list-style-type: none"> <li>• Purulent discharge</li> <li>• Isolated organism</li> <li>• Acute inflammatory reaction with pain, swelling, redness, and heat</li> </ul>
Deep incisional	<p>Infection occurs within 30 days after the operation if there are no implants or within 1 year from the surgery if there are implants. Infections are related to implanted prosthetic material and involves deep fascial layers and muscle tissue, and encompass the following criteria:</p> <ul style="list-style-type: none"> <li>• Purulent discharge from deep tissue layer</li> <li>• Deep incisional spontaneous dehiscence</li> <li>• Deep tissue infection or abscess found by direct examination</li> <li>• Diagnosis made by an experienced surgeon</li> </ul>
Organ space	<p>Infection occurs within 30 days after the operation if there are no implants or within 1 year from the surgery if there are implants. Infections are related to implanted prosthetic and involve organs or anatomical spaces that were manipulated during surgery, and encompass the following criteria:</p> <ul style="list-style-type: none"> <li>• Purulent discharge from a drain</li> <li>• Organisms isolated from suspected area</li> <li>• Deep tissue infection or abscess found by direct examination</li> <li>• Diagnosis made by an experienced surgeon</li> </ul>

**Table 1.** Types and criteria for the diagnosis of surgical wound infection [22].

## 4. Hernia surgery complications

### 4.1. Recurrence

Recurrence of hernia is usually seen as a late complication of hernia surgery. When it occurs, it is generally due to deep infection or due to the excessive tension of the repaired tissues and tissue ischemia. Early over-activity is a principal causative agent of recurrent hernia, as it results in inadequate fibrous tissue formation around the mesh or suture used to approximate the hernia sac. O'Reilly et al. [29] found that patients who underwent a laparoscopic repair for an inguinal hernia had a higher chance of having a recurrence in comparison to those who underwent open repair. Recurrence should be differentiated from other etiologies that could have similar clinical presentations such as seromas in the obliterated hernia sac [30]. Seroma can be defined as fluid-filled dead space in the distal remnants of hernial sac, seromas are usually seen after laparoscopic repair and are sometimes termed as a pseudo-hernia. Other etiologies include hematomas that could be seen in anti-coagulated patients. They could be of a concern if they were of large volume, as they could provide an optimal environment for bacterial

growth and infection. Overall hematomas are far more common than seromas and both could be prevented with a careful hemostasis during surgery [31]. One of the primary causes of hernia recurrence is wound tension; excessive tension could lead to tissues pulling apart thus recurrence at an early stage post-operatively. Excessive tension can also lead to tissue ischemia leading to sutures pulling apart or even falling off. Henceforth new modalities of tension free and suture-free hernia repairs are being promoted by experts such as Lichtenstein [7, 32].

Another factor to consider is the size of the initial hernia defect which is proposed proportional to the risk of developing recurrence in the aftermath of hernia repair. This fact might be explained by the quality of the tissue and fascia surrounding the defect area. As the defect grows bigger it affects the surrounding fascial plans making them weaker and relatively more ischemic in comparison to smaller sized defects. Isik et al. [33] found that higher levels of matrix metalloproteinase s-1-2-9-13, in addition to decreased levels of tissue inhibitors of metalloproteinases-1-2-3 played an integral role in the formation of inguinal hernia, leading to dysfunction of collagen fibers, which will result in weakening of fascia, indicating that a hernia is not only a local issue, but rather a reflection of systemic disease [33]. Other etiologies for hernia recurrence include complicated hernia at presentation such as incarceration or strangulation, in which the tissue will be inflamed and edematous providing a good medium for recurrence as the tissue is unhealthy, to begin with. Another causative agent for recurrence is smoking which is said to increase proteolytic enzymes and decrease protective factors involved in tissue healing [11].

#### 4.2. Neuralgia

Nerve injury could be a terrible consequence of an otherwise successful surgery presenting with pain, loss of sensation or muscular weakness. Neuralgia, commonly known as post-operative pain, is a rather common complication with varying degrees of pain after herniorrhaphy and follows nerve distribution. While some degree of post-operative pain is expected after surgery, for the diagnosis of post-herniorrhaphy neuralgia to be made, pain should persist for more than 3 months, not to be attributed to any other cause and interfere with patient social and/or sexual life [34, 35]. The differential diagnosis for post-herniorrhaphy neuralgia includes hernia recurrence, mesh infection or displacement, osteitis pubis, and fluid collection. Open approach injuries usually affects the ilioinguinal nerve, iliohypogastric nerve, genital branch of the genitofemoral nerve, while injuries to the lateral femorocutaneous nerve is more common with laparoscopic approach, see **Table 2** [1, 36]. Most of the time, the mechanism of injury is attributed to nerve entrapment within the mesh or the suture line. This can be prevented with careful handling of the tissue and preventing over manipulation of the nerves. In laparoscopic approach staple placement below the iliopubic tract decreases the risk of nerve entrapment [37].

Ilioinguinal and iliohypogastric nerves are mostly injured during elevation of the external oblique fascia. The genitofemoral nerve is thought to be injured following cord isolation for cremasteric muscle fibers stripping. As soon as the nerves are identified, they are retracted out of the field by encircling them with a vessel loop and retraction. While injury happens with

Nerve	Area affected
Ilioinguinal nerve	<ul style="list-style-type: none"> <li>• Proximal and medial thigh</li> <li>• Mons pubis and Labia majora</li> <li>• The root of the penis and upper scrotum</li> </ul>
Iliohypogastric nerve	<ul style="list-style-type: none"> <li>• Skin of the hypogastric area</li> <li>• Skin of the gluteal area</li> </ul>
Genitofemoral nerve	<ul style="list-style-type: none"> <li>• Mons pubis and scrotum/labia</li> <li>• Anterior lateral thigh area</li> </ul>
Later femoral cutaneous nerve	Anterior lateral thigh area
Femoral nerve	<ul style="list-style-type: none"> <li>• Motor nerve to quadriceps femoris</li> <li>• Anterior thigh area</li> </ul>

**Table 2.** Commonly injured nerves post-herniorrhaphy [1].

mesh tacking in the laparoscopic approach, which can be side stepped by avoiding tacking in known areas of nerves distribution [1]. O'Reilly et al. [29] found that the risk for post-herniorrhaphy neuralgia and/or numbness was significantly lower with laparoscopic approach when compared with open approach [28].

The first line in the management of neuralgia is usually conservative, mainly by local anesthesia injections in the affected groin. When this modality fails, surgical re-exploration is advocated to identify the affected nerve and excise it. On rare cases of patients presenting with pain not matching the distribution of a single nerve, surgical re-exploration is not advised as it usually will fail improving the pain and may result in damaging more structures [15, 38].

### 4.3. Visceral injury

Bladder, testicular, and vas deferens injuries are among the commonly injured visceral organs with groin herniorrhaphy procedures. Among the least injured structures are the ureters which are more often seen with the laparoscopic approach- the most common type of injury is incomplete transection of the ureter and ureteral perforation [39–41]. Bladder injuries are frequently reported with direct inguinal hernias, and in rare cases could result in a sliding hernia, in which part of the bladder adheres to the hernia sac. Thus, direct sacs are usually inverted back into the peritoneal cavity to avoid unnecessary dissection [42, 43].

Testicular swelling and atrophy could develop after inguinal hernia repair. Swelling and edema of the scrotum are due to hematoma or edema of the inguinal canal that progress inferiorly to the scrotum with gravity. On one hand, testicular atrophy is associated with blood supply injury during the process of dissection and isolation of the cord and usually is a painless complication. On the other hand, testicular pain post-operatively could be a result of torsion or abscess and ruling out such suspicion is done by ultrasound imaging. In the pediatric

population cord traction might cause testicular migration into the inguinal canal. Therefore, before the end of the surgery testes are palpated to ensure the right placement [1, 44].

Vas Deferens injury is considered a rare complication yet the most feared. However, if such an injury was to happen, it requires an urgent urological consultation; injuries range from as severe as transection to a mild laceration. Untreated injuries can result in the formation of anti-sperm antibodies and infertility. Avoiding such dreaded complications is possible by gentle traction of the vas and avoiding grasping or squeezing the Vas Deferens [21].

#### **4.4. Mesh erosion\migration**

Mesh migration or erosion may occur after femoral or inguinal hernias and depends on the extent of the symptoms; hence mesh removal might be advised. Mesh migration can be categorized into primary and secondary. Primary, also known as mechanical, is when the mesh dislodges along the path with least resistance as a result of inadequate fixation or external forces. While secondary, is the slow movement of the mesh through nearby anatomical structures due to body response to a foreign body. The result is an erosion of adjacent structures such as the urinary bladder leading to urinary tract infections or hematuria, bowel injury and subsequent fistula formation, and spermatic cord erosion causing vessel obstruction [45, 46].

Ott et al. [47] reported a case of late intestinal fistula formation as a consequence of an incisional hernia repair using an inter-peritoneal mesh. Animal studies showed that micro-erosions and mesh migration and consequent fistulae formation is decreased when mesh covered with biological material such as collagen [48]. In addition, Leber [49] reported a higher incidence entero-cutaneous fistula formation with the use of Mersilene mesh.

### **5. Post-operative hernia**

Also known as an incisional hernia, post-operative hernias occur as a direct result of fascial tissue failure to heal post laparotomy. Although incisional hernias are frequently seen either post mid line and/or transverse incisions, it can, in theory, happen after any surgical incisions like paramedian and McBurney incisions, and are also seen post laparoscopic surgeries [50]. Such hernias can grow to huge sizes and contain a significant amount of small and large bowel. Previously, the incidence was believed to be around 20%, but recent epidemiological studies estimate the number to be 11%. Around two-thirds of cases may present within the first 12 months after the operation, while the other -third present as a late complication after 5–10 years [51–53]. Risk factors of incisional hernias are increased with advanced patient age, malnutrition, immune-compromised state, smoking, and obesity [12, 15, 54, 55]. Other factors that play an important role include emergency surgery and post-operative wound infection. One major complication of incisional hernia repair surgery is a high recurrence rate, which might reach up to 50%. In some cases this risk is related to the type of surgical approach, whether suture repair or mesh supported repair, and also to the amount of tension applied on the wound edges. Recurrence in this type of hernia is also related to the appearance of unrecognized hernia sites [56]. Another set of complications is related to the empty hernia cavity that is left

behind post reduction of hernia sac, such as hematomas and seromas. Henceforth, experts recommend placement of closed suction drainage; which by itself along with mesh will increase the risk of infection post-operatively [57, 58].

## 6. Enhanced recovery after hernia surgery

The aim of enhanced recovery after surgery protocols is to improve outcomes, lower health cost, while harnessing the benefits by standardizing the medical care [59, 60]. Such protocols are evidence-based guidelines that include minimizing surgical trauma, post-operative pain, reduce complications, and improve outcomes by decreasing the expected length of hospital stay and fasten the patient recovery [61]. Such approach to patient care should be a multi-disciplinary approach including surgeon, anesthesiologists or pain specialists, nursing staff, physical rehabilitation service, and most importantly patient cooperation [62, 63]. Patients who are followed with an enhanced recovery protocol will have the same discharge criteria but will reach these milestones sooner. This approach will usually contain 15–20 elements and will span through the full patient hospital stay; preoperatively, intra-operatively, and post-operatively (**Table 3**) [64]. Before surgery, patient education and counseling about current treatment options and best approach should be discussed. After that, a meticulous overview of the patient general health condition and management of any comorbidities such as renal, cardiac, or respiratory should be done. Intra-operatively prophylactic antibiotics are recommended

Period	Criteria
Pre-operative	<ul style="list-style-type: none"> <li>• Patient education</li> <li>• Medical comorbidities optimization</li> <li>• Bowel preparation</li> </ul>
Intra-operative	<ul style="list-style-type: none"> <li>• Thromboprophylaxis</li> <li>• Antibiotic prophylaxis</li> <li>• Thermal regulation</li> <li>• Fluid maintenance</li> <li>• Avoid drains and nasogastric tube</li> </ul>
Post-operative	<ul style="list-style-type: none"> <li>• Enteral nutrition from day one post-operative</li> <li>• Multimodal analgesia</li> <li>• Antiemetic prophylaxis</li> <li>• Early removal of urinary catheter</li> <li>• Early mobilization</li> </ul>

**Table 3.** Main criteria for enhanced recovery after surgery protocol [66].



before surgery, and fluids should be managed judiciously along with continuous monitoring of the patient vital status [65–67]. While post-operative period is mainly concerned with pain management, fluid and diet, avoidance of nasogastric tube and early urinary catheter removal, early mobilization, and finally early discharge [68, 69].

## **7. Hernia and the pediatric population**

### **7.1. Umbilical hernia**

An umbilical hernia is usually seen in the pediatric population with an incidence of 10–30% at birth in infants of Caucasian ethnicity and higher in those of African-American ethnicity, for unknown reasons [1]. It is also more common in premature infants of all races, and some report a tendency for familial inheritance. While the cause is yet to be identified in most of the cases, an umbilical hernia usually will regress and close on its own by 2–3 years of age with less than 10% needing surgical intervention.

Meanwhile, umbilical hernias in adults have a different clinical presentation, most being acquired not congenital with a male to female ratio of 3:1. The adult-type umbilical hernia usually will need surgical intervention for it to close and usually are symptomatic at time of presentation. A typical presentation will be of an exquisitely tender peri-umbilical mass overlying the skin; long-standing untreated umbilical hernia might result in thinning of covering skin and ulceration due to pressure necrosis of the adjacent skin. While small umbilical hernias could pass unnoticed and discovered incidentally. This type of hernia is associated usually with recurrence in the setting of high intra-abdominal pressure. For this reason, surgical repair is offered for incarcerated hernia or a progressively symptomatic type [3, 11, 70].

### **7.2. Inguinal hernias**

Although the overall incidence of inguinal hernia in the pediatric population is low when compared with adults, the complication that might arise is almost the same. In the age group, bowel incarceration incidence is low, but should this be the case, bowel infarction would happen within 2–3 hours. With bowel infarction, it is not uncommon to get testicular blood supply compromise leading to ischemic necrosis and testicular atrophy with an incidence around 9% according to some studies [71–73]. While in girls, ovarian torsion is reported to happen with inguinal hernia strangulation in about third of patients with incarcerated hernia that contain an irreducible ovary. For this reason, some experts recommend not to delay surgical intervention in this population [74].

### **7.3. Congenital diaphragmatic hernia**

The congenital diaphragmatic hernia is caused by a diaphragmatic defect resulting abdominal viscera herniating to the chest. It usually presents in the first few hours of life with respiratory distress so severe that it could be incompatible with life [75]. In many cases, this condition

can be diagnosed in utero via ultrasound, and for those not diagnosed prenatally, this condition should be suspected in neonates with respiratory distress and absent breath sounds soon after delivery and can be easily diagnosed by chest X-ray [76]. Congenital diaphragmatic hernia complications are categorized into acute, and late-onset complications, the most serious acute complication is persistent pulmonary hypertension of the new born other complications include chylothorax, hemorrhage, and recurrent infection. Furthermore, the spectrum of late complications includes chronic respiratory disease, recurrent hernia, spinal/chest wall abnormalities, neurological, and gastrointestinal complications [77, 78].

## 8. Watchful waiting vs. intervention in hernial disease

The complication of hernia surgery is low; but it could have a significant impact on the patient life, should it happen. Thus, many patients with asymptomatic hernias prefer to delay surgical intervention until needed. As the natural history of an untreated hernia is generally unknown, many practitioners recommend an elective surgery to treat the hernia. Fitzgibbons et al. [79] followed 720 men, half of which had a surgical intervention and half underwent watchful waiting and were followed up to 4.5 years. The authors concluded that watchful waiting was a suitable option to manage a minimally symptomatic inguinal hernia as the overall risk of complication is low [80].

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### References

- [1] Zinner M. Maingot's Abdominal Operations. [S.l.]: Mcgraw-Hill Education; 2018
- [2] Rutkow I, Robbins A. Demographic, classificatory, and socioeconomic aspects of hernia repair in the United States. *Surgical Clinics of North America*. 1993;**73**(3):413-426
- [3] Rutkow I. Demographic and socioeconomic aspects of hernia repair in the United States in 2003. *Surgical Clinics of North America*. 2003;**83**(5):1045-1051

- [4] Caglayan F, Caglayan O, Cakmak M, Saygun O, Somuncu S, Ulusoy S, et al. Investigation of OH-proline contents of hernia sacs in children and comparison with adults. *European Journal of Pediatric Surgery*. 2005;**15**(4):258-261
- [5] Dent B, Al Samaraee A, Coyne P, Nice C, Katory M. Varices of the round ligament mimicking an inguinal hernia: An important differential diagnosis during pregnancy. *The Annals of the Royal College of Surgeons of England*. 2010;**92**(7):e10-e11
- [6] Ijpma F, Boddeus K, de Haan H, van Geldere D. Bilateral round ligament varicosities mimicking inguinal hernia during pregnancy. *Hernia*. 2008;**13**(1):85-88
- [7] Schumpelick P. Inguinal hernia repair in adults. *The Lancet*. 1994;**344**(8919):375-379
- [8] O'Dwyer P, Norrie J, Alani A, Walker A, Duffy F, Horgan P. Observation or operation for patients with an asymptomatic inguinal hernia. *Annals of Surgery*. 2006;**244**(2):167-173
- [9] Gallegos N, Dawson J, Jarvis M, Hobsley M. Risk of strangulation in groin hernias. *British Journal of Surgery*. 1991;**78**(10):1171-1173
- [10] Ścierański A. Duration of groin hernias and accompanied symptoms before beginning of treatment of hernias. *Polish Journal of Surgery*. 2008;**80**(12)
- [11] Srinath S, Prashanth H, Suma K. Complicated groin hernias: Risk factors, conservative management and timing of surgical management. *Journal of Evolution of Medical and Dental Sciences*. 2013;**2**(34):6502-6508
- [12] Ge B, Huang Q, Liu L, Bian H, Fan Y. Risk factors for bowel resection and outcome in patients with incarcerated groin hernias. *Hernia*. 2009;**14**(3):259-264
- [13] Molloy D, Kaloo P, Cooper M, Nguyen T. Laparoscopic entry: A literature review and analysis of techniques and complications of primary port entry. *The Australian and New Zealand Journal of Obstetrics and Gynaecology*. 2002;**42**(3):246-254
- [14] Ahmad G, Gent D, Henderson D, O'Flynn H, Phillips K. Laparoscopic entry techniques. *Cochrane Database of Systematic Reviews*. 2015;**31**(8):6583
- [15] Chandler JG, Corson SL, Way LW. Three spectra of laparoscopic entry access injuries. *Journal of the American College of Surgeons*. 2001;**192**:478
- [16] McGoldrick K. Surgeon volume and operative mortality in the United States. *Survey of Anesthesiology*. 2004;**48**(2):111-112
- [17] Samee A, Adjepong S, Pattar, J. Late-onset mesh infection following laparoscopic inguinal hernia repair. *Case Reports*, 2011(nov 11 1), bcr0920114863-bcr0920114863
- [18] Delikoukos S, Tzovaras G, Liakou P, Mantzos F, Hatzitheofilou C. Late-onset deep mesh infection after inguinal hernia repair. *Hernia*. 2006;**11**(1):15-17
- [19] Ovington L. Hanging wet-to-dry dressings out to dry. *Advances in Skin and Wound Care*. 2002;**15**(2):79-84
- [20] Madhok B, Vowden K, Vowden P. New techniques for wound debridement. *International Wound Journal*. 2013;**10**(3):247-251

- [21] Cruse P, Foord R. The epidemiology of wound infection: A 10-year prospective study of 62,939 wounds. *Surgical Clinics of North America*. 1980;**60**(1):27-40
- [22] Mangram A, Horan T, Pearson M, Silver L, Jarvis W. Guideline for prevention of surgical site infection. *Infection Control and Hospital Epidemiology*. 1999;**20**(04):247-280
- [23] Carlson M. Acute wound failure. *Surgical Clinics of North America*. 1997;**77**(3):607-636
- [24] van Ramshorst G, Nieuwenhuizen J, Hop W, Arends P, Boom J, Jeekel J, Lange J. Abdominal wound dehiscence in adults: Development and validation of a risk model. *World Journal of Surgery*. 2009;**34**(1):20-27
- [25] Harris R, Dodson M. Surgical wound infection and management of extrafascial wound disruption. *Postgraduate Obstetrics and Gynecology*. 1996;**16**(7):1
- [26] Pollock A. Commentary on complete dehiscence of the abdominal wound and incriminating factors by Pavlidis TE et al. *The European Journal of Surgery*. 2001;**167**(5):355-355
- [27] Greenall M, Evans M, Pollock A. Midline or transverse laparotomy? A random controlled clinical trial. Part I: Influence on healing. *British Journal of Surgery*. 1980;**67**(3):188-190
- [28] Ellis H, Coleridge-Smith P, Joyce A. Abdominal incisions: Vertical or transverse? *Postgraduate Medical Journal*. 1984;**60**(704):407-410
- [29] O'Reilly E, Burke J, O'Connell P. A meta-analysis of surgical morbidity and recurrence after laparoscopic and open repair of primary unilateral inguinal hernia. *Annals of Surgery*. 2012;**255**(5):846-853
- [30] Mayo W. An operation for the radical cure of umbilical hernia. *Annals of Surgery*. 1901;**34**(1):276-280
- [31] Zaid T, Herring W, Meeks G. A randomized trial of secondary closure of superficial wound dehiscence by surgical tape or suture. *Female Pelvic Medicine and Reconstructive Surgery*. 2010;**16**(4):246-248
- [32] Glassow F. Recurrent inguinal and femoral hernia. *British Medical Journal*. 1970;**1**(5690):215-216
- [33] Isik A, Gursul C, Peker K, Aydın M, Fırat D, Yılmaz İ. Metalloproteinases and their inhibitors in patients with inguinal hernia. *World Journal of Surgery*. 2017;**41**(5):1259-1266
- [34] Bay-Nielsen M, Perkins F, Kehlet H. Pain and functional impairment 1 year after inguinal Herniorrhaphy: A Nationwide questionnaire study. *Annals of Surgery*. 2001;**233**(1):1-7
- [35] Kehlet H, Jensen T, Woolf C. Persistent postsurgical pain: Risk factors and prevention. *The Lancet*. 2006;**367**(9522):1618-1625
- [36] Tverskoy M, Cozacov C, Ayache M, Bradley E, Kissin I. Postoperative pain after inguinal Herniorrhaphy with different types of anesthesia. *Anesthesia and Analgesia*. 1990;**70**(1):29-35
- [37] Klein S, Greengrass R, Warner D. Paravertebral somatic nerve block for outpatient inguinal herniorrhaphy. *Regional Anesthesia and Pain Medicine*. 1998;**23**(Sup 1):54

- [38] Mirdehghan M, Yazdanjo M, Sadri B, Akhavantafti E, Ghaei E. Postoperative analgesia in inguinal Herniorrhaphy: Infiltration of 0.25% bupivacaine before incision vs before repair of incision. *Regional Anesthesia and Pain Medicine*. 2008;**33**(1):e152
- [39] Al-Awadi K, Kehinde E, Al-Hunayan A, Al-Khayat A. Iatrogenic ureteric injuries: Incidence, aetiological factors and the effect of early management on subsequent outcome. *International Urology and Nephrology*. 2005;**37**(2):235-241
- [40] Basic D, Ignjatovic I, Potic M. Iatrogenic ureteral trauma: A 16-year single tertiary center experience. *Srpski Arhiv za Celokupno Lekarstvo*. 2015;**143**(3-4):162-168
- [41] Marcelissen T, Den Hollander P, Tuytten T, Sosef M. The incidence of Iatrogenic ureteral injury during open and laparoscopic colorectal surgery. *Surgical Laparoscopy, Endoscopy and Percutaneous Techniques*. 2016;**26**(6):513-515
- [42] Edey M. Complications of endoscopic and laparoscopic surgery: Prevention and management. *Archives of Surgery*. 1998;**133**(4):464-464
- [43] Das D. Meta-analysis of randomized clinical trials comparing open and laparoscopic inguinal hernia repair. *British Journal of Surgery*. 2004;**91**(5):647-647, 91: 253
- [44] Amid P. A strategy for circumventing the problem of prostate surgery subsequent to preperitoneal inguinal hernia repair. *Hernia*. 2004;**8**(3)
- [45] ocot A, Gerharz E, Riedmiller H. Urological complications of laparoscopic inguinal hernia repair: A case series. *Hernia*. 2010;**15**(5):583-586
- [46] Agrawal A, Avill R. Mesh migration following repair of inguinal hernia: A case report and review of the literature. *Hernia*. 2005;**10**(1):79-82
- [47] Ott V, Groebli Y, Schneider R. Late intestinal fistula formation after incisional hernia using intraperitoneal mesh. *Hernia*. 2004;**9**(1):103-104
- [48] Aubé C, Pessaux P, Tuech J, du Plessis R, Becker P, Caron C, Arnaud J. Detection of peritoneal adhesions using ultrasound examination for the evaluation of an innovative intraperitoneal mesh. *Surgical Endoscopy and Other Interventional Techniques*. 2003;**18**(1):131-135
- [49] Leber G. Long-term complications associated with prosthetic repair of incisional hernias. *Archives of Surgery*. 1998;**133**(4):378
- [50] Bucknall T, Cox P, Ellis H. Burst abdomen and incisional hernia: A prospective study of 1129 major laparotomies. *BMJ*. 1982;**284**(6320):931-933
- [51] LeBlanc K. Laparoscopic incisional and ventral hernia repair: Complications?How to avoid and handle. *Hernia*. 2004;**8**(4):323-331
- [52] Mudge M, Hughes L. Incisional hernia: A 10 year prospective study of incidence and attitudes. *British Journal of Surgery*. 1985;**72**(1):70-71
- [53] Read R. Recent trends in the management of incisional herniation. *Archives of Surgery*. 1989;**124**(4):485

- [54] Rosin D. Prevention of incisional hernia in midline laparotomy with Onlay mesh: A randomized clinical trial. *World Journal of Surgery*. 2014;**38**(9):2231-2232
- [55] Meena K, Ali S, Chawla A, Aggarwal L, Suhani S, Kumar S, Khan R. A prospective study of factors influencing wound dehiscence after midline laparotomy. *Surgical Science*. 2013;**04**(08):354-358
- [56] Mäkelä J, Kiviniemi H, Juvonen T, Laitinen S. Factors influencing wound dehiscence after midline laparotomy. *The American Journal of Surgery*. 1995;**170**(4):387-390
- [57] Cobb W, Kercher K, Heniford B. Laparoscopic repair of incisional hernias. *Surgical Clinics of North America*. 2005;**85**(1):91-103
- [58] Awaiz A, Rahman F, Hossain M, Yunus R, Khan S, Memon B, Memon M. Meta-analysis and systematic review of laparoscopic versus open mesh repair for elective incisional hernia. *Hernia*. 2015;**19**(3):449-463
- [59] Kehlet H, Wilmore D. Evidence-based surgical care and the evolution of fast-track surgery. *Annals of Surgery*. 2008;**248**(2):189-198
- [60] Ljungqvist O, Scott M, Fearon K. Enhanced recovery after surgery. *JAMA Surgery*. 2017;**152**(3):292
- [61] Delaney C, Fazio V, Senagore A, Robinson B, Halverson A, Remzi F. 'Fast track' postoperative management protocol for patients with high co-morbidity undergoing complex abdominal and pelvic colorectal surgery. *British Journal of Surgery*. 2001;**88**(11):1533-1538
- [62] Gustafsson U, Scott M, Schwenk W, Demartines N, Roulin D, Francis N, et al. Guidelines for perioperative care in elective colonic surgery: Enhanced recovery after surgery (ERAS®) society recommendations. *Clinical Nutrition*. 2012;**31**(6):783-800
- [63] Slim K, Joris J. The egg-and-chicken situation in postoperative enhanced recovery programmes. *British Journal of Anaesthesia*. 2017;**118**(1):5-6
- [64] Kehlet H, Joshi G. Enhanced recovery after surgery. *Anesthesia and Analgesia*. 2017;**125**(6):2154-2155
- [65] Feldheiser A, Aziz O, Baldini G, Cox B, Fearon K, Feldman L, et al. Enhanced recovery after surgery (ERAS) for gastrointestinal surgery, part 2: Consensus statement for anaesthesia practice. *Acta Anaesthesiologica Scandinavica*. 2015;**60**(3):289-334
- [66] Maurice-Szamburski A, Auquier P, Viarre-Oreal V, Cuvillon P, Carles M, Ripart J, et al. Effect of sedative premedication on patient experience after general anesthesia. *Journal of the American Medical Association*. 2015;**313**(9):916
- [67] Rollins K, Lobo D. Intraoperative goal-directed fluid therapy in elective major abdominal surgery. *Annals of Surgery*. 2016;**263**(3):465-476
- [68] Kamel H, Iqbal M, Mogallapu R, Maas D, Hoffmann R. Time to ambulation after hip fracture surgery: Relation to hospitalization outcomes. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*. 2003;**58**(11):M1042-M1045

- [69] Muller S, Zalunardo M, Hubner M, Clavien P, Demartines N. A fast-track program reduces complications and length of hospital stay after open colonic surgery. *Gastroenterology*. 2009;**136**(3):842-847.e1
- [70] Darling J. Radical operation for the cure of umbilical hernia. *The Dublin Journal of Medical Science*. 1910;**129**(6):428-430
- [71] Puri P, Guiney E, O'Donnell B. Inguinal hernia in infants: The fate of the testis following incarceration. *The Journal of Urology*. 1984;**132**(2):425
- [72] Rowe M. Incarcerated and strangulated hernias in children. *Archives of Surgery*. 1970;**101**(2):136
- [73] Walc L, Bass J, Rubin S, Walton M. Testicular fate after incarcerated hernia repair and/or orchiopexy performed in patients under 6 months of age. *Journal of Pediatric Surgery*. 1995;**30**(8):1195-1197
- [74] Boley S, Cahn D, Lauer T, Weinberg G, Kleinhaus S. The irreducible ovary: A true emergency. *Journal of Pediatric Surgery*. 1991;**26**(9):1035-1038
- [75] Wiener E. Congenital diaphragmatic hernia: Pathophysiology and pharmacologic support. *Journal of Pediatric Surgery*. 1981;**16**(6):1043
- [76] Sakurai M, Donnelly L, Klosterman L, Strife J. Congenital diaphragmatic hernia in neonates: Variations in umbilical catheter and enteric tube position. *Radiology*. 2000;**216**(1):112-116
- [77] Dillon P, Cilley R, Mauger D, Zachary C, Meier A. The relationship of pulmonary artery pressure and survival in congenital diaphragmatic hernia. *Journal of Pediatric Surgery*. 2004;**39**(3):307-312
- [78] Jancelewicz T, Chiang M, Oliveira C, Chiu P. Late surgical outcomes among congenital diaphragmatic hernia (CDH) patients: Why long-term follow-up with surgeons overall. *Journal of Pediatric Surgery*. 2013;**48**(5):935-941
- [79] Fitzgibbons R, Giobbie-Hurder A, Gibbs J, Dunlop D, Reda D, McCarthy M, et al. Watchful waiting vs repair of inguinal hernia in minimally symptomatic men. *The Journal of the American Medical Association*. 2006;**295**(3):285
- [80] Nugud A, Nugud S. Long-standing asymptomatic Inguinoscrotal hernia. *Sultan Qaboos University Medical Journal*. 2017:e250-e251

