

Review Article**Incisional Hernia: Risk Factors, Incidence, Pathogenesis, Prevention and Complications****Ismat M Mutwali,**Associate Professor of Surgery, Faculty of Medicine, Fellow of FAIMER (SAFRI), Alzaeim Alazhari University,
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Abstract: Incisional hernia is one the most common postoperative complications of abdominal surgery. Its incidence remains high in spite of the great improvement in the techniques and suture materials used for closing the abdominal wall incisions. Many procedures and techniques were described for preventing and repairing incisional hernia, but up to date there is lack of consensus regarding the best approach for preventing and repairing it. The aim of the present article is to review the risk factors, incidence, pathogenesis, prevention and complication of incisional hernia. A database search was performed using a combination of the search terms: incisional hernia, risk factors, incidence, pathogenesis, prevention and complications. Some of the relevant reference lists were search manually to obtain more relevant literature.**Keywords:** Incisional hernia (IH), Risk factors, Incidence, Pathogenesis, Prevention, Complications

INTRODUCTION

Incisional hernia (IH) is defined by the European hernia society (EHS) as "any abdominal wall gap with or without a bulge in the area of postoperative scar perceptible or palpable by clinical examination or imaging" [1]. Development of IH can follow any type of surgical incision, whatever its site or size, even the incision of the laparoscope trocar can cause it. IH was reported as a complication of abdominal surgery since the early days of surgery, Greedy (1836) and Maydl (1886) reported repair of IH, Judd (1912) and Gibbon (1920) described the anatomical repair of IH [61], Kirschner (1910) introduced the auto graft (fascia lat, skin) and hetero graft (skin) for repairing IH [70].

The incidence of IH is still high, in spite of the great improvement in the techniques and suture materials used for closing the abdominal wall incisions. Many procedures and techniques were described for preventing and repairing IH; using different suture materials, suture repair, prosthetic repair, combination of different techniques or laparoscope. In spite of the many efforts for reducing the incidence of IH, still there is a lack of consensus regarding the best approach for preventing and repairing IH, because most of them are

followed by complications [2]. IH represents a major surgical issue for surgeons of all specialties. The number of articles published and indexed in pubmed, about I H increased by 3.9 folds during the decades 1991-2000 and 2001-2010, indicating the importance of the issue of IH [3].

The aim of the present article is to review the risk factors, incidence, pathogenesis, prevention and complication of IH in the first part. The management of the IH and its complication will be reviewed in a separate article. A database search was performed on midline pubmed and Cocharane database, using a combination of the search terms: incisional hernia, risk factors, incidence, pathogenesis, prevention and complications. Some of the relevant reference lists were also searched manually to obtain more relevant literature.

RISK FACTORS OF INCISIONAL HERNIA (IH)

The development of IH is associated with a number of risk factors which may be related to patient, nature of the primary surgery and biological factors. Table 1 shows the common general risk factors for the development of IH.

Table 1: Risk factors of incisional hernia

Patient related factors	Age: more than 60 years; Gender: Male Obesity: BMI>25Kg/m ² Co morbidities: Diabetes mellitus, chronic lung diseases, obstructive jaundice, immuno suppression in organ transplant patients, Chemotherapy and Steroid therapy.
Surgery related factors	Emergency operations, bowel surgery, abdominal aortic aneurism, stoma closure, operations for peritonitis, re-laparotomy. Technique and suture material used for closure of the abdominal incisions. Wound infection, long operating time, increased blood loss, surgeon experience.
Biological factors	Collagen and metalloproteinase synthesis Smoking Nutritional deficiencies

Patient`s related risk factors

The old age and male gender are considered as risk factors because wound healing is delayed and collagen synthesis decreased [4-7] beside the fact that the old age is the age of chronic diseases and malignancies. Obesity, expressed as body mass index (BMI) is a major risk factor of IH [6, 8-12]. A BMI>24.4kg/m² is considered as one of the predicting factors for developing IH, at 6 months after midline laparotomy [9]. Co-morbidities: Diabetes mellitus, jaundice, malignancies, chronic lung diseases, prostatism, chronic constipations, as well as heavy lifting are well known risk factors for hernia development by increasing the intra abdominal pressure, delaying healing and delaying collagen synthesis [8, 13-16] Immuno-suppression in organ transplant patients increases the rate of wound infection, wound dehiscence and IH [17]. Steroid therapy for certain chronic diseases or as a bolus therapy for immuno suppression in organ transplant patients and chemotherapy are risk factors of IH [15, 16, 18].

Surgery related risk factors

Emergency surgery increases the risk of IH as a result of post operative complications, inadequate patient preparation, use of drains and the midline approach in the emergency operations [15]. The nature of the surgical operation; operations in which there may be wound contamination(bowel resection or secondary peritonitis), surgery for malignant tumours, abdominal aortic aneurysm, stoma closure, major abdominal surgeries and operations followed by open abdomen treatment with negative pressure and delayed primary wound closure, are all risk factors for development of IH [15, 19, 20-24]. Selection of the site incision, suture materials and the technique of closure of incision are important factors. Midline abdominal incision has a higher risk for developing IH compared to transverse and oblique incisions (11%, 4.7% and 0.7% respectively) [4, 25] The technique of closing the abdominal fascia and the suture material used play a major role in developing IH [7, 15, 27]. Re-laparotomy is a strong risk factor [5]. Also factors related to the surgeon experience, long operation time and increased blood loss increase the risk of IH [7, 10]. Wound infection and wound dehiscence are major risk factors

for IH. This risk is more prominent after burst abdomen with evisceration. [4, 24, 25-28]. The 10-year cumulative risk for developing IH after wound dehiscence is 78% regardless of suture material and technique used [29]. Murray (2911) reported an increase of IH by 1.9 fold after surgical site infection. Operation on the previously infected or the relatively avascular scar tissue increases the risk of IH [5, 29, 30].

Biological risk factors

The unchanged incidence of IH over the last decades can only be explained by the presence of biological factors which are individual dependent. These factors include: synthesis of different types of collagen, enzymes defects, smoking and some nutritional deficiencies [31]. Defective collagen metabolism and synthesis is one of the major factors involved in the development of IH. Patients with IH have a reduced ratio of collagen I: collagen III as well as a reduced ratio of matrix metalloproteinase 1 (MMP1) to matrix metalloproteinase2 (MMP2).These reductions in the synthesis of different types of collagen and enzymes play a role in the development of IH. Biological elements like copper and zinc are important for the integrity of collagen because they are necessary for the synthesis of the enzyme Laysyl oxidase which contribute in the integrity of the collagen molecule [32-34]. The presence of other biological factors (Plasminogen activator inhibitor, urokinase plasminogen activator inhibitor) in the scar tissue may contribute in the development of IH [34]. Smoking is a well know risk factor for hernia development [5, 10, 15, 16, 31, 35-37.] Smokers have four folds higher risk than non-smokers. Smoking can cause a peripheral tissue hypoxia which increases the risk of wound infection by reducing the oxidative killing mechanism of the neutrophils [5]. Preoperative cessation of smoking reduces the rate of surgical site infection but not the rate of wound failure and hernia development [37].

INCIDENCE OF INCISIONAL HERNIA

IH is one of the commonest complications of abdominal surgery .Its incidence is dependent on the acting risk factors. IH can develop at different times from surgery, but 90% of incisional hernias occur during the first three years of surgery [38]. It varies

between 11% - 20% in uncomplicated wounds [4, 8, 27, 38]. The incidence is higher in the presence of specific risk factors and in special situations. IH develops more common following midline incisions than other incisions [4, 8, 27, 38]. The incidence of IH after Mc Burney's incision in female is 0.7% [25]. Continuous sutures using a slowly absorbable or non-absorbable mono-filament suture material reduces the incidence of IH. Using good bite and short interval between stitches to respect the ratio of suture length to wound length > 4 decreases the risk of IH [13, 39-43]. The use of non-absorbable suture material for closing the midline laparotomy incisions reduces the incidence of IH [44]. IH is more prevalent following open resection than laparoscopic resection of the colon (18% vs 7%) [46]. In patients with high BMI the incidence of IH increases significantly [11, 20, 22, 47]. The incidence of IH is increased after wound dehiscence, treatment of open abdomen, after aortic reconstructive surgery and surgery for secondary peritonitis and stoma closure [11, 20, 22, 29, 45].

PATHOGENESIS OF INCISIONAL HERNIA

Incisional hernia occurs when the tissue structure and function is disturbed over a previous surgical scar. Two main biological mechanisms are involved in the pathogenesis of IH: primary fascial pathology and secondary wound failure over a surgical scar. The extra cellular molecular defect that develops after these two mechanisms leads to IH [35]. Abnormal collagen metabolism, enzymes deficiency or excessive syntheses are the early mechanisms that are involved in the development of IH. Acquired collagen defect is related to smoking and nutritional deficiencies. The fascial pathology secondary to wound failure is due to formation of the scar tissue and to the defects in the function of the fibroblasts and collagen structure. Wound failure and loss of the normal healing process induces appearance of abnormal fibroblasts that leads to abnormal collagen, because fibroblasts are the main source of collagen synthesis [35]. Straining during coughing, heavy lifting, abdominal distention and ascites can induce secondary changes on tissue fibroblasts. Wound ischemia due to intra operative shock, closure under undue tension or in the avascular scar tissue leads to defective tissue repair. Obesity increases the intra abdominal pressure, but the exact mechanism by which obesity causes IH is not well defined, a mechanical stress could be the cause [11, 12]. The consequences of the abnormal collagen metabolism are delayed and defective collagen synthesis and an increase in the activity of the protease enzymes at the level of the wound which increases collagen degradation. The end result is a decrease in type I and type III collagen, a decreased ratio of collagen I to collagen III. The reduction of the collagen synthesis and wound tensile strength increases the risk of the mechanical wound failure [35]. Other factors that contribute to the quantitative and qualitative wound failure include: inadequate hemostasis that results in

hematoma formation with its mechanical disruption effect on the surgical wound, delayed or defective inflammatory response that results in wound contamination and hence prolongation of the transition to the proliferative phase of healing and delayed fibroblast response that in turn leads to delaying in synthesis of wound matrix. Following wound infection, multiplication of bacteria in the wound affects the process of healing which results in a decreased and defective collagen synthesis. This defective collagen synthesis leads to wound dehiscence and late IH development [5]. Smoking apart from reducing the oxidative killing mechanism of neutrophils, it can also decrease collagen synthesis and produces a decrease in collagen I to collagen III ratio. Smoking also increases the degradation of the connective tissue as a consequence of enhancing the imbalance between protease activity and their inhibitors. Acute tissue hypoxia caused by smoking leads to tissue necrosis in the fragile tissues of the wound [45]. The postulation that IH is developed as a result of multiple biological factors action is raised after the failure of reducing the incidence of IH by other non- biological measures [5, 32, 33].

PREVENTION OF INCISIONAL HERNIA

There is no standardized intervention or procedure agreed upon for prevention of IH. Measurements that should be taken to reduce the incidence of IH include: general measures for reducing the post operative complications, interventions or procedures used to prevent IH in high risk patients and measures related to the technique and selection of suture material used for closing abdominal wall incisions. Preoperative preparation by controlling the major risk factors reduces the risk of IH. Administration of preoperative appropriate antibiotics for all patients undergoing emergency or elective surgery where there is a risk of contamination and in high risk patients is well known to reduce postoperative complication including IH. The appropriate approach and technique for closure of the abdominal incision in high risk patients reduces the risk of IH. Post operative control of pain ,prevention of respiratory complications by respiratory training and early mobilization, reducing the operative time, gentle manipulation of tissues and avoiding intra operative contamination are some of the general measures that reduces IH [41-45]. The selection of suture material and the technique for closing laparotomy incisions plays a major role in prevention of IH.

There are some procedures and interventions, used for prevention and management of IH that played a major role in reducing the incidence of IH and its recurrence: These include: technique and suture material selected for closure of the abdominal incisions; the use of prosthetic repair of IH; the introduction of minimally invasive surgery for treating IH and control of wound infection and wound dehiscence. Selection of a slowly absorbable or non absorbable mono filament

suture material and increasing the ratio of suture length to wound length > 4 significantly reduced the incidence of IH [13, 28-40- 44, 48, 49]. The use of prosthetic material, synthetic or biologic, and the different surgical techniques for prevention of IH in high risk patients proved to be safe and effective in reducing the incidence of IH [50-53]. The cumulative rate of recurrence of IH was reduced by using mesh for repairing IH [54]. The introduction of the minimally invasive surgery in the sixties of the last century contributed in the reduction of the incidence of IH. Le Huu [4] reported an incidence of 22% versus 0.7% for open versus laparoscopic surgery. Skipowth [46] reported a 4%-18% incidence after open colorectal resection and 7% for laparoscopic resection, while Liaguna [6] found no reduction in the incidence following laparoscopic colectomy. Prevention of wound infection and wound dehiscence by using appropriate prophylactic antibiotics and suitable techniques is known to reduce the incidence of IH [27, 45, 47]. Patients with previous wound infection have a 41% risk to develop re infection in subsequent surgery even in the absence of clinical signs of infection. This high rate

of infection can be reduced by prophylactic antibiotics [30].

Table 2 shows different techniques and suture materials used for closing abdominal incision in order to prevent IH. Continuous suturing using mono filament slowly absorbable or non absorbable suture material, combined with increasing the ratio of suture length to wound length >4 is the most effective method for reducing the incidence of IH [13, 27, 39, 41, 42, 55]. For high risk patients some procedures and intervention were used to reduce the incidence of IH. Table 3 shows different procedures used for prevention of IH and their results. A number of experimental interventional studies were conducted to evaluate their role in prevention of IH. Injection of transforming growth factor beta 2 into the abdominal wall increases the production of collagen I and III reduced the incidence of IH in rats [36] Administration of transforming growth factor beta 2, basic fibroblast growth factor and inter leukine 1 beta reduces the incidence of IH in rats [56]. Treating abdominal wall incisions with a sustained –release of basic fibroblast growth factor reduced the incidence of IH and its recurrence in rat’s model [57].

Table 2: Techniques and suture material used for prevention of IH

Sl. No.	Technique and suture	Results	Author & date
1	Continuous suture of midline incision using synthetic material	Good, reduced the rate of IH	Trimbos [66]
2	Increasing the SL:WL > 4	Reduces the incidence of IH	Israelsson [40, 41]
3	Increasing the SL:WL>4,using continuous technique and monofilament slowly absorbable suture	Decrease IH incidence and its recurrence	Jargon [13]
4	Continuous mattress suture +SL:WL>4	Superior to interrupted single sutures	Hoer [62]
6	Small suture using non absorbable material	Fewer postoperative complications and IH	Capella [64]
7	Continuous suture using slowly absorbable material	Optimal method for closure of abdominal incisions	Van` t [43]
8	using proline for closing midline incision in high risk patients	Effective, easy and reducing IH incidence	Murtaza [46]
9	Using small stitches continuous+ increasing SL:WL>4	Reduces IH incidence	Millabourn [2], Israelsson [41]
10	Continuous suturing using mono filament slowly absorbable suture material	Reduces incidence of IH	Albertstmeier [48] Diener [49]
11	Small stitches sand continuous technique	Better results in prevention of IH	Rahbari [55]
12	Long stitches VS short stitches (Big bite VS small bite)	Big bite has higher incidence of IH(18% VS 5.6%)	Millabourn [2]
	Antibacterial braided suture material (fast or slow absorbable)	Does not increase the rate of IH	Justinger [45]

VA=versus, SL= suture length, WL= wound length, IH= incisional hernia

Table 3: some of the procedures and interventions used for prevention of IH

Sl. No.	Procedure or intervention	Results	Author/ date
1	Polygalactin mesh insertion for high risk patients	Does not decreases incidence of IH	Pans [63]
4	Rectus sheath relaxation incisions	Safe, reduces rate of wound dehiscence and IH	Marwah [50]
5	Using a bio absorbable plug for prevention of trocar site IH	simple feasible and effective	Moreno [67]
6	Sub fascial non absorbable mesh for midline incisions in high risk patient	safe, effective and provide strengthening of wound	Elkhadrawy [51]
7	Using biologic mesh placement in high risk patients	Safe effective and reducing incidence from 17.7% to 2.3%	Liaguna [52]
8	Pre peritoneal Proline mesh placement in high risk patients	Safe and effective in preventing IH	Hidalgo [65]
9	Placement of Proline mesh pre peritoneal in high risk patients	Effective for reducing the rate of IH	Aborayia [53]

COMPLICATIONS OF INCISIONAL HERNIA

Untreated IH enlarges by time and makes repair difficult. IH can cause abdominal pain or discomfort, limitation of the daily activity and unsightly appearance. Complication of IH are not common, but can be very serious and even life threatening. Intestinal obstruction, incarceration or strangulation and entero cutaneous fistula can develop. Skin ulceration and spontaneous rupture can threaten the life of the patients with untreated IH [58-60].

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