Review Article

Incisional hernia management

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Abstract

Incisional hernia (IH) is one of the most prevalent postoperative complications of the abdominal surgery. Its recurrence rate is still high in spite of the many techniques and procedures described for the repair of IH and its prevention. The management of IH requires knowledge and expertise to reduce the high rates of postoperative complications and recurrence. The diversity and complexity of IH, may force the hernia surgeon to individualize the treatment, because it seems that there is no universal procedure or technique that can be applied to all type of IHs. The aim of the present review was to provide the surgeons and surgical trainees with updated account on the management of IH. A database search on midline, PubMed and Cochrane database performed to provide comprehensive review.

Key words: Incisional hernia, management, review

INTRODUCTION

A database search was performed on med line and PubMed using the search terms: Incisional hernia and management. Some of the relevant reference lists were searched manually to obtain more relevant literature. Selected review articles and meta-analysis were also included to provide a comprehensive review of the management of incisional hernia.

Incisional hernia (IH) is one of the most common complications of abdominal surgery. Its prevalence varies between 11% and 23% depending on the presence of the specific risk factors, the site of the incision and the technique and suture material used for closure of abdominal incisions.[1,2] The recurrence rate of IH varies, depending on the method of repair. It is as high as 58% following suture repair; using prosthetic mesh the rate of recurrence is dependent on the type of mesh, technique and site of placement of mesh and methods of fixation of the mesh. The onlay technique is followed by 20% recurrence rate, the sublay by 2–12% and the inlay technique by 4% recurrence rate and the laparoscopic repair of IH (LRIH) has a lower rate of recurrence compared to open repair.[3,4] The risk factors of IH can be patient-related and these include age >60 years, obesity body mass index (BMI) >25 kg/m^2, co-morbidities diabetes, chronic lung diseases, obstructive jaundice, immuno-suppression in transplant patients and chemotherapy and steroid therapy. Surgery related risk factors include: Emergency operations, bowel surgery, abdominal aortic aneurism, stoma formation and 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 and surgeon experience. The biological factors that play a role in the development of IH are collagen and metalloproteinase synthesis, smoking, and nutritional deficiencies.[5-9]

Incisional hernia should be repaired, because if left it will enlarge and make repair difficult. The surgical treatment of IH is indicated to relieve symptoms (abdominal pain and discomfort), to prevent the possible complications (strangulation, skin ulceration) or for urgent treatment of the acute complications (incarceration, strangulation or the rare rupture of IH). Symptoms of IH can develop in 33–78% but only 5–15% of them develop acute symptoms.[4] IH is better repaired electively because

Access this article online	
Quick Response Code:	Website: www.sudanmedicalmonitor.org
	DOI: 10.4103/1858-5000.157505

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the emergency treatment of IH is associated with higher postoperative complications especially in the elderly patients.[10]

PREVENTION OF INCISIONAL HERNIA

A consensus on the closure of the surgical incisions recommended that a continuous suture technique of the main fascial layer, with slowly absorbable or nonabsorbable suture material is followed by a low incidence of IH. The technique of closing the abdominal incisions that respect the rule of good bite and short interval (a minimal distance of 1 cm from the fascial margin, and <1 cm distance between stitches) that keeps the ratio of suture length to incision length equal to 4:1, is valid and it can reduce the incidence of IH.[11-14] Prophylactic mesh placement reduces the rate of IH and so the use of mesh in stoma formation.[15,16]

Preoperative control of the risk factors is mandatory to achieve good results and reduce the postoperative complications. Prophylactic antibiotics are recommended for patients with high-risk factors and in the presence or anticipation of complications (contaminations, long operative time, usage of drains, urinary catheters). Thromboembolic prophylaxis should be administered according to the presence of risk factors for individual patients.[17]

DIAGNOSIS

Incisional hernia is readily diagnosed by virtue of the presence of a reducible swelling over a previous surgical scar and palpating the hernial defect. Computed tomography (CT) scan is needed for diagnosing IH in obese patients, repeated previous operations, and large hernias with possible loss of the domain and in traumatic hernias. CT is very useful in detecting up to 98% of recurrences while physical examination detects 88%. Ultrasound is less reliable than CT scan in differentiating recurrences, Seroma, and postoperative bulge.[4]

The surgical management of IH represents a challenge for the surgeons; it can be extremely complex and difficult due to the heterogeneity of the IH. The repair of IH necessitates extensive training and expertise to determine the best treatment. The hernia surgeon should be aware of the different techniques and the various types of prosthetic materials. Complex IH may need a collaboration of a team of the general surgeon, plastic surgeon, and anesthetist working together to achieve more.

Numerous procedures were described for repairing IH. Many of these procedures stand the challenge of time, and many others gained no popularization. This plenty of procedures is an indication of the great diversity of IH and the difficulty of its repair. To overcome this great diversity of IH and to compare the results and outcome of the different procedures a system of classification is needed. The European Hernia Society proposed a classification that consider the site of the hernia, the size (width and length) and whether the IH is a primary one or recurrent[18] [Table 1].

Repair of IH was reported since the early days of abdominal surgery. Greedy 1836, Maydl 1880, reported repair of IH. Judd 1912 and Gibbon 1920 described the anatomical repair of the IH, and Kirschner 1910 introduced autograft of fascia lata for repairing IH.

The procedures described for repairing IH are either: Direct suture repair (anatomical repair); repair using prosthetic

Table 1: EHS classification of IH

Midline hernias From xyphoid process to pubic bone and medial to the lateral margin of the rectus sheaths on both side	Subxiphoid	M1	From the xiphoid process till 3 cm caudally
	Epigastric	M2	From 3 cm below the xiphoid process till 3 cm above the umbilicus
	Umbilical	M3	3 cm above the umbilicus to 3 cm below the umbilicus
	Infraumbilical	M4	From 3 cm below umbilicus to 3 cm above pubis
	Suprapubic	M5	From the pubic bone till 3 cm cranially
Lateral hernias From costal margin to inguinal region and from the lateral margin of the rectus sheaths to the lumber region	Subcostal	L1	Between the costal margin and the horizontal line 3 cm above the umbilicus
	Flank	L2	Lateral to the rectus sheath in the area 3 cm above and below the umbilicus
	Iliac	L3	Between a horizontal line 3 cm below the umbilicus and the inguinal region
	Lumber	L4	Lateral and dorsal to the anterior axillary line
	Recurrent IH	Yes ☐	No ☐
	Length cm.....		Width cm.....
Width taken as Semi quantitative measurement of the size	W1 <4 cm ☐	W2 ≥4-10 cm ☐	W3 ≥10 cm ☐

IH = Incisional hernia, EHS = European Hernia Society

material, synthetic, biological or composite mesh; or using fascial flaps, mobilization of anatomical layers or a combined procedure using >1 technique to reduce the rate of recurrence and postoperative complications and since 1993 laparoscopy was introduced for repairing IH. Recently more advanced techniques were described, Robotic repair and NOTES. Table 2 shows some of the procedures and techniques used for repairing IH.

Open suture repair is the simplest and oldest method of repairing IH. It is associated with high recurrence rate, but it can be performed in a short time. IH with a defect smaller than 3 cm can be safely repaired by direct suture repair. Large IH before the era of synthetic mesh were repaired by direct suture or using natural autograft.[4,15] Open synthetic mesh repair was introduced in 1954 by Stock, when he used a nylon mesh for repairing IH.[19] In 1958, Usher *et al.* reported the first cases of IH that were repaired by synthetic mesh.[20]

Synthetic meshes are usually manufactured from polymers, like polypropelene (proline [PP]), polyethelene-terephthalat (polister, PET), polyvenelidenflouride (PVDF) or polytetraflouroethelene (PTFE). The ideal synthetic mesh for repairing IH should be strong enough to resist tearing, have minimal tendency for adhesion formation, good to excellent tissue in growth, minimal shrinkage, having no tendency to infection and fistula formation and causing minimal chronic abdominal pain or discomfort.[4,21] Proline (PP) is a hydrophobic, neutral electrically, resistant to biodegradation, but it has an intense biological response, hence an strong incorporation into the abdominal wall leading to postoperative chronic pain and discomfort. Polister (PET) has similar biological response as PP and a tendency for degradation by time. Expanded PTFE (ePTFE) is a laminar material with minimal inflammatory reaction and less scar formation. PVDF is a new polymer with promising results in the stage of experimental studies. Partially absorbable meshes (hybrid

Table 2: Some of the methods used for repairing IH and their outcomes

Author/year	Method	Follow-up period	Recurrence (%)
Suture repair			
Gibbon 1920	Anatomical repair was described		
Maingot 1954	Keel repair of IH was reported		
Dur, *et al.* 2009	Two-layered repair	30 months	4.5
Hope 1985	Da Silva repair	1-4 years	0
Mesh repair			
Stock 1954	Introduced nylon mesh		
Usher 1962	Proline mesh	1-year	10
Wagman *et al.* 1984	Proline mesh for recurrent IH	a month-4 years	0
Mollg *et al.* 1991	proline mesh for massive IH	6 months-10 years	8
Validire 1986	Stainless steel	4 years	9
Cerise *et al.* 1975	Mersiline mesh polyster	1-4 years	8
Bauer *et al.* 1987	ePTFE (composite mesh)	3.5-38 months	11
Fascial flaps			
Hamilton 1968	Fascia lata	6-21 months	7
Houston *et al.* 1988	Latissimus dorsi	5 months-5.5 years	0
Venugopalan 1980	Gracilis	5 years	0
Fog-Anderson 1963	Buried skin	6 months-7 years	0
Hagstrom *et al.* 1976	Dermal graft	1-4 years	7
Legbo 2013	De-epthelialized dermal flap	3 months-4.5 years	0
Samah *et al.* 1984	Porcine dermal collagen	3-5.5 years	0
Smitten *et al.* 1982	Strips of dermal skin	1-15 years	26
Szerfin 2008	Bovine pericardial patch	NA	NA
Guerra, *et al.* 2014	Porcine acellular dermal matrix	1-48 months	8.9
Combined repairs			
Adoloff *et al.* 1989	Polyester mesh+aponeurotic flap	2 months-3 years	5
Hossein, *et al.* 2008	Combined fascial+mesh repair	16 months	6.9
Loh *et al.* 1992	Anterior rectus flap+double repair	55 months	0
Ramirez 1991	CST was described		
Reilingh deVries, *et al.* 2003	CST (large IH)	12 months	32
Mirelle *et al.* 2011	CST + double mesh	Median=13 months	0
Wells 1955	Over lapping bilateral reflected flaps of the anterior rectus sheaths		

NA = Not available, IH = Incisional hernia, ePTFE = Expanded polytetraflouroethelene, CST = Component separation technique

meshes) were invented to reduce the intensity of the inflammatory responses while maintaining the strength and the easy manipulation; they are a combination of PP, PET with poly glactin 910.[21,22] The synthetic prosthetic meshes have their own drawback: Recurrence of IH due to mesh migration, retraction or shrinkage, mesh erosion into a viscera or through the skin. Synthetic meshes are the cause of the chronic abdominal pain after repair and are incriminated in the causation of Seroma.[4,21,22] Contraction or shrinkage of the mesh is a common event in hernia repair by a synthetic prosthesis. Mesh contraction is due to retraction of the fibrotic scar tissue around the fixed mesh, hence the importance of the overlap distance of mesh to avoid the recurrence, because 99% of the recurrences occur at the edge of the mesh.[4]

Biological meshes or grafts are used for repairing IH, because these materials can promote cellular infiltration and enhance the neovascularization and regeneration of the graft into the native tissue. Biological meshes were used in the repair of IH in the presence of infection or anticipation of contamination, where synthetic mesh is contraindicated in these situations.[23]

Biological meshes are usually derived from tissues that are processed to remove the cellular elements and protein. Dermacol is a dermal collagen of porcine origin which has been processed to remove all cells and protein, leaving acellular sheet of collagen it is a cross-linked. Alloderm is acellular dermal matrix derived from the donated human skin (banked human tissue). Surgisis is manufactured from the submucosa of the small intestine of porcine origin, which processed to remove cells and protein. Collamend it is a cross-linked porous lyophilized a cellular porcine dermal collagen matrix.[24,25]

Open synthetic mesh repair can be used in one of the three common techniques: Inlay, Sublay or onlay according to the site of fixation of the mesh in relation to the abdominal wall layers. The inlay technique the synthetic mesh is indirect contact with bowel inside the peritoneal cavity. It is associated with serious complications like erosion of bowel and entero cutaneous fistulae. Usage of composite meshes can overcome this disadvantage of the inlay technique.

The sublay technique (Rives *et al.* 1973) the mesh is placed retro muscular overlaying a closed peritoneum and posterior rectus sheath.[26] It is difficult, time-consuming and can be used only for repairing midline IH. In the onlay technique, the mesh is placed in the subcutaneous tissue in the prefascial space on the abdominal wall.[27] It is useful for all types of IH other the midline hernias. Many modifications and combination of the mesh repair of IH were described aiming to reduce postoperative complications.

Many studies were published comparing the different open procedures of repairing IH; some compared suture repair to mesh repair, or the different technique of mesh repair and other the different modification of the open repair of IH. Luijendijk *et al.* compared suture repair with mesh repair and found that the cumulative rates of recurrence at 3 years is higher following suture repair compared mesh repair (43% vs. 24%). The operative time was shorter for suture repair than mesh repair (45 min vs. 58 min) and the mean hospital stay was 6 days for suture repair and 5 days for mesh repair.[28] Regarding the comparison of suture repair to mesh repair in onlay or sublay position, the pooled recurrence rate was 33.3% for suture repair and 16.4% for mesh repair. There were no differences regarding chronic postoperative pain and cosmetic appearance between the two methods of repairing IH. Wound infection was more common after mesh repair than suture repair (0% vs. 10.1%).[29-31] Conze *et al.* compared the light weight mesh to the standard heavy weight mesh and reported that recurrence rate after lightweight mesh was 17% and it was 7% after the use of heavy weight mesh, but there were no differences regarding the chronic postoperative pain between the two types of meshes.[32] The studies that compared the position of the mesh in the onlay or sublay position showed that the recurrence rate for the onlay repair was 7.4–10% and that for sublay was 9–13.9%. The mean operative time was significantly shorter after suture repair than after mesh repair. No differences were reported in regards to hospital stay and postoperative pain between the onlay and the sublay position of mesh.[33,34] The comparison between PP meshes and skin autograft showed that there were no differences regarding the postoperative pain and rate of infection, while the recurrence rate was 12.3% following skin autograft and it was 8.6% after PP mesh.[29] Andersen reported a recurrence rate of only 15% and an overall complication rate of 13% following median follow-up of 35 months using onlay technique.[35] Repairing large and recurrent IH using either intra peritoneal double mesh or onlay technique showed that the recurrence rate was 27% for onlay technique versus 0% for double mesh, but there were no significant difference regarding the other postoperative complications.[35]

Component separation technique (CST) was described in 1991 by Ramirez *et al.* It entails mobilization of the lateral attachment of the rectus sheaths from the external oblique at the linea semilunaris. The CST enables creation of bilateral flaps that make closure of defects as big as 30 cm in width possible and easy.[36-38] CST can be used for repairing large IH and to close the abdomen without subsequent respiratory distress or abdominal compartment

syndrome.[15] Endoscopic CST is feasible and it is followed by less postoperative morbidities, because the dissection of the abdominal wall is less extensive, compared to the open procedure, and hence the complications such as wound infection and necrosis are less following endoscopic CST.[17] Open CST is followed by a high recurrence rate and postoperative complications; to overcome these complication, CST combined with double mesh repair was described by Bröker *et al.* 2011 and their short-term results showed low recurrence rate, but high rate of wound infection.[39] Comparing CST versus mesh repair for large IH, de Vries reported that both techniques had high recurrence rate (56% vs. 58%) but the CST was performed in a shorter time than mesh repair.[40]

Laparoscopic repair of incisional hernia was introduced by LeBlanc *et al.* in 1993.[41] It was expected to reduce the operative time, peri operative and postoperative complications. LRIH is safe and feasible for defect <10 cm in diameter, but the operative time is longer in patients with defects larger than 15 cm. LRIH can be performed in obese patients and even for those with morbid obesity (BMI > 50 kg/m^2). Absolute contraindication for LRIH include: Patients with previous multiple IH repairs, due to the dense adhesion, patients with loss of abdominal domain because the content cannot be reduced without complications, open abdominal wounds, because the insufflations will fail and when there is an additional surgical procedure that is planned.

The recurrence rate of LRIH and that of open repair are similar, whereas the complications of the LRIH are fewer but may be more serious due to bowel injuries (1.55% vs. 0.63% for open repair).[15,17,42] The most serious complication of the LRIH is the unrecognized small bowel injury (0.68–2.9%). The rate of the unrecognized bowel injury of the open repair is similar to that of LRIH. The incidence of the surgical site infection (SSI) following LRIH is 1.1% whereas that of the open repair is 10%. Other reported complications of the LRIH include: Seroma formation, postoperative chronic pain, postoperative bulge, and recurrence.

The comparison of the outcome of the IH repair by open technique or by laparoscopy showed that there were no significant differences between the two procedures in many of the parameters used in the comparison. There were no significant differences regarding Seroma formation, operative time, quality of life, cosmetic appearance, postoperative chronic pain, and recurrence rate.[42] The LRIH is followed by significant higher incidence of bowel injury compared to open repair, but LRIH had a lower rate of SSI. Hospital stay is significantly shorter after LRIH. The cost of LRIH is 9 times higher than the cost of the open repair, but the cost effectiveness of the LRIH is better. This cost effectiveness is due to the reduced morbidity and mortality, fewer Intensive Care Unit admissions, shorter hospital stay, and fewer 30-day readmissions after laparoscopic repair.[42-46] Laparoscopic surgeons should master the technique to prevent complications. Adhesiolysis should be performed by sharp dissection near the abdominal wall away from the bowel using bipolar coagulation that is safer than monopolar diathermy that should be avoided. Biological meshes should be avoided in the elective repair of IH. PVDF, ePTFE, coated PP, and polyester meshes can be used safely in the LRIH with minimal rate of bowel adhesion and recurrence rate.[17,42]

The management of IH in the presence of intra peritoneal sepsis or severe wound contamination represents a real surgical challenge. Repair of such hernias depends on the degree of contamination, which may range from minor leak from an enterotomy to severe mesh infection. The surgical decision in such situation is determined by the extension of the contamination or sepsis and on the experience of the surgeon as well as a selection of method of repair. Suture repair will result in an unacceptable high recurrence rate, and using synthetic mesh is contraindicated. Multi-stage repair of contaminated IH was recommended by some surgeons, where during the first stage the infection is controlled and then after 6–12 months a definitive repair can be performed in a clean field.[23,25,47] Another alternative for repairing contaminated abdominal hernia is a single stage repair using biological mesh.[23,48]

Loss of domain is that condition in which part of the abdominal content is found for a long time or permanently outside the peritoneal cavity, in the hernial sac (second abdomen). Returning this content may result in respiratory distress. Repair of IH with significant loss of domain that is, >20% of the abdominal content is permanently resident outside the peritoneal cavity, may result in abdominal compartment syndrome, due to high increase in the intra peritoneal pressure. Such hernias cannot be repaired primarily with complete closure of the abdominal wall. Temporary closure of the abdominal wall in hernias with loss of the domain or in the presence of abdominal sepsis and infected wound can be achieved using the modified sandwich vacuum pack technique.[49] The repair of IH with loss of the domain needs collaboration of a team formed of the general surgeon, plastic surgeon, and Anesthetist. Procedures that increase the volume of the peritoneal cavity like CST, preoperative progressive pneumo peritoneum, and the preoperative use of tissue expansion are some of the measures that can help in repairing large IH with loss of domain, and hence prevent the development of abdominal compartment syndrome.[15,50]

UNUSUAL SITE OF INCISIONAL HERNIA

Parastomal IH can complicate 6.2% of the ileostomies and up to 48% of colostomies. Direct suture repair can result in 50% recurrence rate. Mesh repair reduces this rate to 25%. Laparoscopic parastomal hernia repair can be performed safely, but it requires good experience. It takes longer operative time, and it is followed by more intra operative complications. Parastomal IH can be prevented by prophylactic mesh insertion at the time of stoma formation. The incidence of IH following temporary stomas, in patients with high-risk factors can be as high as 60%.[51-53]

Lumber IH can develop following surgery for nephrectomy, abdominal aortic aneurism, abdominal wall tumor resection and iliac bone donation. Its prevalence is 20–30%. It is difficult to repair because it is situated in a region of the abdomen where the muscles are flat. It is commonly associated with nerve damage that leads to muscle atrophy.[54,55]

Trocar site IH is that hernia that develops through the site of the incision for the laparoscope trocar. Its prevalence is 0.65–2.8%. Trocar site IH can develop immediately after surgery and it results in small bowel obstruction; or it can occur late after a month or more and presents as a bulge at the site of incision or rarely it can present as complete dehiscence of the wound. Prevention of the trocar site IH can be achieved by closure of the wound under direct vision especially when the diameter of the incision is 10 mm.[15,56]

Incisional hernia in women at child-bearing age: Premenopausal women, who intend to have pregnancy, need to have special attention when considering repairing of IH. This special consideration is warranted because the subsequent pregnancy necessitates an elastic abdominal wall to allow expansion as pregnancy progress. Hence, the use of synthetic mesh should be avoided, and the hernia can be repaired by direct suture repair or CST.[57] There are few case series that reported LRIH, using synthetic mesh and subsequent pregnancy without any complication.[58]

The use of drains in the management of IH is controversial; there is no evidence to support the use of drains or not using the drains.[59] The author advice the use of drains especially when there was extensive dissection.

In the management of IH, there is good evidence that open mesh repair is superior to suture repair, but wound infection rates are higher following mesh repair; so a careful balance between the rate of wound infection and recurrence rate should be considered during the repair of IH.[60]

The recurrence rate is the most important outcome of IH repair. It is dependent on the surgeon experience, and on patient`s factors and on factors related to the structure of the tissues at the site of the IH. The patient`s and tissue factors are commonly constant and difficult to be modified, but the experience of the surgeon (the technique used for repair, type of mesh and method of fixation of mesh) can be modified and improved to prevent or reduce recurrence rates. Elimination of the risk factors before surgery, prevention of wound infection, and standardized technique are some measures to be taken to avoid failures and significantly reduce the recurrence rate of IH.

Considering the heterogeneity and complexity of the presentation and management of IH; it seems that there is no single procedure or technique that is useful or universally applicable to all types of IH.

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How to cite this article: Mutwali IM. Incisional hernia management. Sudan Med Monit 2015;10:17-24.

Source of Support: Nil. **Conflict of Interest:** None declared.