

Current Solutions for Prevention of Incisional Hernia After Abdominal Wall Closure

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Background: The Incisional hernia is a complication of abdominal surgeries, including laparotomy, and stoma creation. It impairs the patient's quality of life and body image in addition to other complications.

Aim of the review: A literature review about the current data for the best, most feasible and most appropriate solutions for abdominal wall repair. Providing a tool for surgeons to choose the best method for repair in a way that prevents incisional hernia development, appropriate for every situation and specific for every patient.

Methods: Literature research in American National Center for Biotechnology Information (NCBI), PubMed, Google scholar, Egyptian Knowledge Bank, and science direct.

Conclusion: Prevention of incisional hernias could be the key to improving patient outcomes even more after abdominal surgeries. In this overview, currently available methods to decrease the incidence of incisional hernia are discussed. Vast number of these methods has succeeded in giant hernia repair and might succeed in patients with open abdomen as well.

Keywords: Incisional Hernia; Abdominal Wall Surgery; Repair; Surgeons; Reconstruction; Laparotomy; Prevention.

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DOI: 10.21608/SVUIJM.2021.69772.1153

Received: 28 March, 2021.

Revised: 7 April, 2021.

Accepted: 10 April, 2021.

Published: 13 April, 2024

Cite this article as: Mohammed K. Alammary, Mahmoud Abdelhameid Mahmoud, Mohammed M. Mubarak , Mahmoud Abdelsattar Mohammed.(2024). Current Solutions for Prevention of Incisional Hernia After Abdominal Wall Closure. *SVU-International Journal of Medical Sciences*. Vol.7, Issue 1, pp: 505-514.

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Introduction

The open abdomen is an intense challenge that surgeons encounter, since of the metabolic, physiological, and dynamic effects that this situation involves (Palominos et al., 2019).

Through a long time, the management of complex abdominal situations such as the open abdomen and the strategies that deal with the temporary closure of the abdomen has become common and beneficial tools for the use in the field of surgery (Demetriades and Salim, 2014).

In so many cases the surgeon is forced to leave the abdominal cavity open after surgery, leading to an open abdomen (Atema et al., 2015).

Incisional hernias are very common complications; the incidence is 12.8% at 2 years of follow-up. Among patients who have undergone colorectal cancer resectional surgery, the rate of incisional hernia has been reported as high as 39.9%, including both open approach 40.9% and laparoscopic approach 37.1% (Pereira et al., 2013)

1. Incisional hernia

An abdominal wall hernia is a condition in which abdominal organs protrude intermittently or continuously from a defect in the abdominal wall. In incisional hernia the defect occurs in the scar of the wound of the previous operation. (Burger, 2006).

Incisional hernia is a common complication after abdominal surgeries. The incidence is between 2% and 20%. In the United States alone, about 200,000 incisional hernia repair operations are done every year. The problem increases with the discouraging results of incisional hernia repair. The frequency of the complications leads to the importance of determination of the cause. This maybe because of imperfect operative techniques or due to post-operative complications such as surgical site infection, and raised abdominal pressure.(Burger, 2006).

2.1. Development of Incisional Hernia

In surgery, the abdominal wall is cut to

enter the abdominal cavity. After that, the abdominal wall edges are sutured together. An incisional hernia develops when wound edges partially separate early before complete collagen bridging occurs. A defect then is formed through this defect abdominal cavity contents may protrude especially when intra-abdominal pressure increases (Israelsson, 2002).

2.2. Risk Factors for Incisional Hernia Development

2.2.1. Wound Healing.

Conditions that hinder wound healing are often present prior to surgery and include age, diabetes, obesity and smoking.

Old age is thought to be causing atrophy of the wall of the abdomen and connective tissue abnormalities. This leads to a decrease in the tensile strength of scar tissue (Bucknall et al., 1982; Sørensen et al., 2005).

Diabetes is known for the high incidence of infection which threatens wound healing. Atherosclerosis in diabetics also has the same effect on wound healing (Sugerman et al., 1996).

Obesity is a major threat for any surgery leading to development of incisional hernias as well as recurrence after hernia repair. (Sauerland et al., 2004; Lin et al., 2009; Desai et al., 2016).

The use of laparoscopy played an effective role in reduction of postoperative incisional hernias following bariatric surgeries. Orenstein and Martindale have found that in patients with BMI \geq 50, the recurrence and wound morbidity rate is extremely high. (Orenstein and Martindale, 2017).

Smoking leads to impaired wound healing through reduction of both blood and tissue oxygen tension, and the deposition of collagen in healing wounds (Jensen et al., 1991; Knuutinen et al., 2002; Sørensen et al., 2010).

2.2.2. Raised Abdominal Cavity Pressure.

Increased intra-abdominal pressure causes fatigue of the scar tissue, which may predisposes to wound failure and formation of hernia. Increased intra-abdominal pressure can

be affected by a combination of conditions, including chronic cough, obesity, ascites, constipation, labor, and ileus. (Guillou et al., 1980);(Gislason et al., 1995; Wissing et al., 1987; Regnard et al., 1988).

2.2.3. Surgical Technique and Perioperative Care.

2.2.3.1. Type of Incision.

In the meta-analysis by Grantcharov and Rosenberg comparing transverse (oblique and transverse) with vertical (midline) incisions. Results came in favor of the transverse incision (Grantcharov and Rosenberg, 2001).

Incisional hernias are less common in small transverse incisions than in midline incisions. (Blomstedt and Welin-Berger, 1972; Garcia-Valdecasas et al., 1988; Sanz-Lopez et al., 1999; Ros and Zambon, 1987).

In the case of bilateral transverse incisions, hernia rates comparable to that of the midline incision (10%) are expected (Lord et al., 1994; Johnson et al., 1995; Ellis et al., 1984).

The paramedian incision has low rates of hernia formation against the midline incision (Guillou et al., 1980; Cox et al., 1986; Kendall et al., 1991).

Pfannenstiell incision leads to low hernia rates of 0-1% (Biswas, 1973; Pietrantonio et al., 1991; Griffiths, 1976).

The use of laparoscopy has significantly reduced incisional hernia rates. Most authors suppose an incisional hernia rate of 0.2-1.8%(Holzinger and Klaiber, 2002).

From the above data we can say that In comparison to midline and bilateral incisions, lateral paramedian incision, unilateral transverse incision, Pfannenstiell incision, and laparoscopy result in lower incisional hernia rates. (Burger, 2006).

The midline incision should be limited as much as possible to emergency cases and for surgeries which need full exposure of the abdomen (Burger et al., 2002).

2.2.3.2. Suturing method And Material

The recommendations from the study of Hodgson et al were clear. They recommended

the use of non-absorbable materials, and continuous suturing technique. And found no difference in hernia rates after use of polydioxanone (PDS) or polypropylene (Hodgson et al., 2000).

Weiland et al compared layered closure with mass closure of the abdomen, results were in favor of mass closure (Weiland et al., 1998).

2.2.3.3. Suture Length – Wound Length Ratio (SLWL Ratio)

It can be determined by dividing the length of the used suture thread by the length of the wound. The number represents the extent of the tissue bite and the distance between stitches. In the study on SLWL ratio by Israelsson et al hernia rates decreased from 23.7% to 9 % when the SLWL changed from < 4 to ≥ 4 . (Israelsson and Jonsson, 1993).

2.3. Classifications of Incisional hernia

2.3.1. Classification by Chevrel and Rath

The classification of incisional hernias that of Chevrel and Rath describes incisional hernias as median (M) or lateral (L) (Chevrel and Rath, 2000, Fig.1). It categorizes hernias into four subcategories and documents hernia size and the number of recurrences(Dietz et al., 2007).

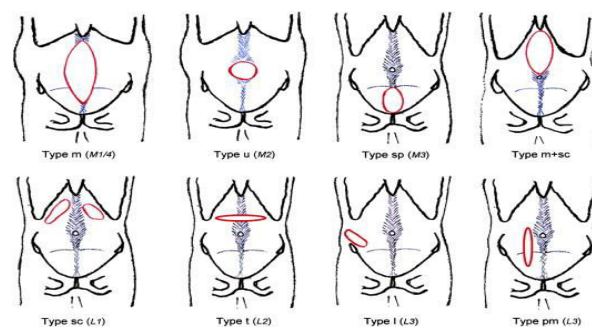


Fig.1. Classification according to Chevrel and Rath(Chevrel and Rath, 2000).

2.3.2. Morphological Classification of incisional hernias

This classification is based on morphology, hernia size in cm, and risk factors for recurrence. To be more suitable for routine clinical practice. (Dietz et al., 2007).

Table 1. Morphological Classification of incisional hernias (Dietz et al., 2007)

Primary or recurrence	Morphology (M)	Size in cm (S)	Risk factors for recurrence (RF)
p (primary)	M m (median)	S a x b	RF Obesity (BMI >25)
r (recurrence)	m-sc (median*) u (umbilical) sp (suprapubic) sc (subcostal) t (transversal) l (lumbar) pm (paramedian) nc (other)		Male Nicotine abuse Wound contamination Age > 45 years Underlying disease 2. intervention < 1 month > 2 interventions/year Postop. complication

... M... S...X... RF...

The number of recurrences is indicated after the 'r' (e.g. r1, r2, r3, etc.)

See figure 1 For 'm', 'u' and 'sp' the following body type features are relevant: subcostal angle; attenuated muscles, voluminous abdomen. *m-sc = median with narrow subcostal angle

a and b: Size in cm

In the absence of risk factors (-). For each risk factor (+), motto exceed (+++).^{12,14}

3. Prevention of incisional hernia

Incisional hernia is significantly less common after laparoscopic procedures compared to open surgery (4.3 vs. 10.1) (Kössler-Ebs et al., 2016; Dietz et al., 2018).

Obesity, smoking, uncontrolled diabetes mellitus, malnutrition, and surgical site infection are all factors affecting wound healing, and optimization of these conditions before surgery will decrease the incidence of incisional hernia (Orenstein and Martindale, 2017).

3.1. The Importance of Laparotomy Closure

It is recommend to do closure of the abdomen by mass closure, continuous suturing, and by non-absorbable suture material (Burger, 2006).

Continuous sutures result in lower incisional hernia rates (Diener et al., 2010).

Meta-analyses showed a better results when using mass closure (Weiland et al., 1998; Bosanquet et al., 2015).

Small bite size (being 5 mm bites every 5 mm) increases the laparotomy closure strength and decreases the incisional hernia incidence (Millbourn et al., 2009; Harlaar et al., 2009). The same results have been recently confirmed by a randomized controlled trial: the STITCH trial (Deerenberg et al., 2015).

3.2. Hughes abdominal repair

The ‘Hughes Repair’ (Professor Les Hughes, 1932–2011), also famous as the ‘far-and-near’ or ‘Cardiff Repair’ (Shukla et al., 1998) Combines mass closure with an alternating cascade of horizontal and two vertical mattress sutures.

theoretically distributing the load over the length and the width of the suture line (Harries et al., 2017).

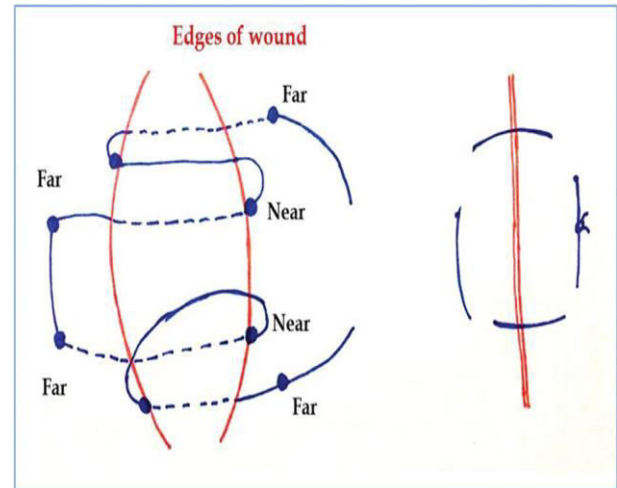


Fig.2. Hughes repair (Zaitoun et al., 2020)

Hughes repair technique showed promising results better than conventional closure in both emergency and elective laparotomy cases, in terms of wound dehiscence and Incisional hernias formation. (Rajasekaran et al., 2017).

3.3. Prophylactic mesh augmentation

Using a mesh is another variety to minimize and avoid incisional hernias formation. Mesh augmentation means fixing a mesh to the fascia of abdominal wall during closure of midline incisions in emergency cases. The use of prosthetics made from non-absorbable rather than absorbable materials has shown better results. (Pans and Desai, 1995).

A growing number of studies showed that prosthetic mesh if used in an onlay position to prevent the occurrence of incisional hernia is efficient and easy. In a study of 172 patients who underwent prophylactic onlay mesh implantation results showed that the rate of incisional hernia was 7.6% with a 5 years follow-up (Hernando et al., 2016).

Prophylactic mesh may be used to avoid incisional hernias in patients undergoing emergency abdominal surgery without increasing postoperative complications, as per Argudo et al. (Argudo et al., 2014).

The Primary Mesh Closure of Abdominal Midline Wound trial was a randomized clinical trial including patients with high risk either an abdominal aortic aneurysm or a BMI ≥ 27 who were having an elective laparotomy. The trial compared between primary suture closure, onlay mesh placement and sublay mesh placement. The results of the study revealed that both techniques of mesh augmentation lowered the rate of incisional hernia formation compared to primary suture closure (13% or 18% vs 30%)(Jairam et al., 2017).

4. The open abdomen

The definition is deliberately avoiding fascial closure of the abdomen after the cavity has been opened (Palominos et al., 2019; Beckman et al., 2016).

Through a long time, the management of complicated abdominal situations such as the open abdomen and the temporary closure of the abdomen have become common and beneficial options for the use in the field of surgery (Demetriades and Salim, 2014).

The indications for open abdomen include damage control surgery with second look, severe abdominal sepsis, and, treatment of an abdominal compartment syndrome.

4.1. Damage control

The trauma surgeon's primary objective during the damage control laparotomy should be to controlling active haemorrhage, followed by tight infection control, and finally temporary abdominal closure. (Lee and Peitzman, 2006).

Following a damage control surgery it is preferable to keep the abdomen open because of the high risk of intra-abdominal hypertension. The following stage of damage control surgery protocol is stabilization of the general condition and the physiological parameters of the patient in the intensive care unit, followed by definitive surgical care

(Demetriades, 2012).

4.2. Abdominal sepsis

The use of open abdomen in the treatment of serious secondary peritonitis has always been a point of discussion. (Demetriades and Salim, 2014).

Some patients with severe secondary peritonitis can deteriorate from severe sepsis and septic shock to organ dysfunction, myocardial suppression, and coagulopathy. (Moore and Moore, 2012).

In the case of severe peritonitis, there is no clear evidence or strong recommendation for the use of an open abdomen. So, caution and personalization of patient's plan of care should be the main concern when using the open abdomen approach. (Coccolini et al., 2018).

4.3. Abdominal compartment syndrome

Intra-abdominal hypertension is described as a sustained pathologic rise in intra-abdominal pressure of 12 mm Hg or more. (Palominos et al., 2019).

Abdominal compartment syndrome is defined as a prolonged rise in intra-abdominal pressure more than 20 mm Hg that is consistent with new organ dysfunction or failure (Demetriades and Salim, 2014, Kirkpatrick et al., 2013).

Table 2. Intra-abdominal pressure (Manu et al., 2006)

Grade	Pressure in mm HG
Normal	5–7 mm Hg
Intra-abdominal Hypertension Grade I	12–15 mm Hg
Grade II	16–20 mm Hg
Grade III	21–25 mm Hg
Grade IV	> 25 mm Hg

The best treatment for abdominal compartment syndrome is decreasing the decompressive laparotomy (Beckman et al., 2016; Demetriades and Salim, 2014; Kirkpatrick et al., 2013; Manu et al., 2006).

5. Management of the open abdomen

Following the clinical scenarios just discussed, life-saving, decompressive laparotomy and temporary abdominal closure with future restoration of anatomic continuity

of the abdominal wall are now the mainstream approach (Howdieshell et al., 2004).

In the systematic review and meta-analysis by Sharrock et al a three phase algorithm for management of open abdomen was designed.

First phase is temporary abdominal closure. Phase 2 includes delayed primary closure, acute component separation, acute mesh repair or planned ventral hernia which will be repaired later on which is phase 3(Sharrock et al., 2016).

Table 3. Methods of temporary abdominal closure (Townsend et al., 2016)

Technique	Description	Example
Vacuum pack	Perforated polyethylene sheet placed under fascia, covering abdominal viscera Sterile surgical towels and suction drains placed in wound, covered with adhesive plastic drape; drains placed to continuous suction	Barker vacuum pack
Negative pressure wound therapy	Polyethylene encapsulated foam system placed under fascia with negative pressure sponge applied to vacuum device	KCI ABThera negative pressure therapy
Artificial burr	Two opposing Velcro sheets with hooks and loops, sutured to fascial edges Velcro sheets connect in the midline	Wittman patch
Dynamic	Sutures or	Canica

retention sutures	elastomers placed transabdominally , just lateral to rectus fascia bilaterally	ABRA silicone elastomer
Inlay patch	Impermeable prosthesis sutured to fascial edges	Bogota bag
Skin-only closure	Use of towel clips to reapproximate skin in the midline	Towel clip closure

Conclusion

Prevention of incisional hernias could be the key to improving patient outcomes even more after abdominal surgeries. In this overview, currently available methods to decrease the incidence of incisional hernia are discussed. Vast number of these methods has succeeded in giant hernia repair and might succeed in patients with open abdomen as well.

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