



# Prevention of Incisional Hernia: What is new?



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## Abstract

Incisional hernia (IH) is among the commonest post-operative complication after midline laparotomy. In spite of all technological advances its incidence remains 5-26%; prompting surgeons to think about IH prevention techniques. A scrutiny of factors associated with IH clearly shows that most of these are patient related and are beyond the Surgeon's control. However, there are a few Surgeon-related preventive measures which can help in bringing down the incidence of IH. These include efforts directed at reducing surgical site infection, preferred use of laparoscopy over conventional open surgery, preferred use of transverse incision, using current recommendations for midline laparotomy closure, incisional reinforcement in high risk groups by prophylactic mesh, special incisions/ techniques for prevention of IH in special circumstances, identification of high-risk cases and their centralized care, and increasing awareness of safety of synthetic mesh in presence of infection and strangulation. This brief review is based on relevant published literature in 'PubMed' and 'Google Scholar' since 2013. Now that it is possible to identify high risk patients for development of IH, high quality evidence is available for its prevention and the preventive measures do not require expansive resources; time has come to convert available knowledge to implementation.

**Keywords:** Incisional hernia; Risk factors; Prevention

## Introduction

Secure abdominal wall closure after any laparotomy is every surgeon's aim. Despite numerous improvements over the years in suture materials and closure techniques, the incidence of incisional hernia (IH) has not diminished; and 5-26% of patients develop IH after midline laparotomy. This figure goes further up if high risk groups are analyzed separately or if the follow up is for a period longer than 3years or when imaging techniques are employed to look for IH. IH imposes significant healthcare burden, > 300,000IH repairs are done in US alone with an estimated cost of > 3.2Billion Dollars [1]. Magnitude of this problem has prompted the surgeons to think about IH prevention techniques [2]. The present brief point-wise, reader friendly review is based on relevant published literature in 'PubMed' and 'Google Scholar' since 2013.

## Risk Factors for Development of IH After a Midline Incision

These factors are well known and have entered in to surgical folklore: male gender, age > 60years, preoperative anemia, preoperative hypoproteinemia, Body Mass Index > 25, abdominal wall thickness > 20mm, higher visceral and subcutaneous fat, non-elective admission and surgery, co-morbidities, diabetes, malignancy, history of smoking, chronic obstructive pulmonary disease, jaundice, liver disease, ascites, chronic kidney disease, preoperative chemotherapy, previous laparotomy, previous IH, aortic aneurism surgery, bowel surgery, bariatric surgery, creation of an ostomy, closure/ reversal of stoma, longer operative time,

increased blood loss during surgery, blood transfusion, suture to wound length ratio < 4, superficial and deep surgical site infections, wound contamination classification III/ IV, American Society of Anesthesiologists score 3 or 4 points, ventilatory support, immunosuppression therapy, wound dehiscence, postoperative pulmonary problems, postoperative abdominal distension/ intestinal obstruction, postoperative catecholamine-therapy, low institutional surgical volumes and disturbed wound healing.

## What can be done to Prevent IH?

A scrutiny of factors associated with IH clearly shows that most of these are patient related and are beyond the Surgeon's control. Community based anti-obesity and anti-smoking campaigns can reduce obesity and chronic obstructive pulmonary diseases so risks of these two factors can be brought down.

However, there are a few Surgeon-related preventive measures which can help in bringing down the incidence of IH:

### Surgical site infection (SSI)

SSI is among the most important factors-raising the risk of development of IH by 2-10 times-this fact has been known for long and confirmed by several recent studies. Most risk factors for SSI are common with those of development of IH and reducing SSI is an important preventing measure for IH. Compared with superficial SSI, deep SSIs are more strongly associated with the development of IH [3]. A long stitch length is associated with an increase in the

rate of wound infection and IH; this fact has been known for long and has contributed to the evolution of small stitches for abdominal wall closure.

In trying to reduce SSI, it is worth remembering Halsted's basic principles of surgical technique introduced in late 19<sup>th</sup> century regarding tissue handling: gentle handling of tissue, meticulous hemostasis, preservation of blood supply, strict aseptic technique to minimize contamination of wound, minimum tension on tissues during closure, accurate tissue apposition and obliteration of dead space. As expected, laparoscopic surgery is associated with a lower incidence of SSI.

World Health Organization and Center for Disease Control guidelines are now available for the prevention of SSIs [4,5]. These include: pre-surgery full body bath with soap, timely antimicrobial prophylaxis as indicated, skin preparation in the operating room using an alcohol-based agent, maintenance of glycemic control, normothermia, peri-operative oxygen saturation and transfusion of blood products as required. Meaningful reductions in SSI can be achieved by implementing such multidisciplinary care bundle at a hospital-wide level [6].

Appropriate antibiotic prophylaxis can reduce the incidence of SSI by as much as 75%. High quality evidence shows that antibiotics covering aerobic and anaerobic bacteria delivered orally or intravenously (or both) prior to elective colorectal surgery reduce the risk of surgical wound infection [7,8]. Recently combination of probiotics with antibiotics has been shown to reduce SSIs in colorectal Surgery [9].

Topical antimicrobial prophylaxis, before or after operative wound closure; have shown effectiveness in decreasing SSI, but the quality of evidence is very low to moderate [10,11]. Antibiotic-impregnated sutures for abdominal fascial closure have been tried to prevent SSIs, hernias, and/or dehiscence but the evidence is ambiguous [12,13]. SSIs appear to be reduced with subcutaneous suction drains in open abdominal surgery [14].

## Laparoscopy

Advent of and increasing use of laparoscopy has resulted in marked decrease in incidence of IH-across all surgical indications. However, using laparoscopy is not without port-site incisional herniation. A review found overall incidence of port-site incisional hernia as 1.7% (range, 0.3% to 5.4%). The most important factors were older age, higher body mass index, preexisting hernia, trocar design, trocar diameter, increased duration of surgery, and extension of the port site for gallbladder extraction. Awareness of the predisposing factors and modification of closure techniques may help to reduce the risk [15]. As expected, single-incision laparoscopic surgical procedures, using larger ports/ incisions have higher port-site hernia rate of 2.9% at 30 to 36 months' follow-up [16]. Port sites of 10mm and larger diameter fascia should be closed by suture, whereas the risk of hernia development in 5mm trocar placements seems to be a rare complication [17].

## Type of incision

Upper midline incision is known for increased IH [18]. Use of a transverse incision for laparotomy (as compared to a midline laparotomy) and use of a transverse incision, in cases of hand assisted laparoscopy or incision to remove specimen is followed by a significant decrease in the incidence of IH [19-21].

## Current recommendations for midline laparotomy closure

These are in favor of continuous, single layer aponeurotic suture with slowly absorbable or non-absorbable monofilament suture material using the small bites technique which has shown significantly less IHs than a large bites technique. Advantage of small bite technique was known for quite some time, but the clinching evidence was provided by STITCH trial and this soon became part of current guidelines [19,22-24]. A large multicenter randomized control trial is going on as a follow up to STITCH trial and results are expected in 2019 [25].

This recent success of small stitch trial has questioned the traditional guideline of 4-4.9:1 relationship between suture and wound length, as it requires a much longer suture. However, concerns have been raised about effective implementation of appropriate suture to incision ratio and extra attention to fascial closure needs to be inculcated among the surgeons [26,27].

Currently, a trial is going on using the 'Hughes/ Cardiff Repair' which combines a standard mass closure with a series of horizontal and two vertical mattress sutures within a single suture [28]. This, theoretically, distributes the load along the incision length as well as across it. However, this involves the use of two sutures, has the risk of bowel trapping and risk of suture entanglement, takes longer time, longer suture, and adds to the cost.

Recently a 'Herring bone' suturing technique has been published which relies on each successive suture to reduce the tension on the stitch for the next suture to be passed [29]. Herring bone suturing technique has the advantage of both continuous and cross suture methods; it is technically easy, reproducible, safe and can be performed quickly.

## Incisional reinforcement in high risk groups by prophylactic mesh

From small comparative studies to large multicenter RCTs and systemic reviews-all have shown that use of prophylactic mesh in high risk groups can significantly reduce the incidence of IH for midline laparotomy closure (up to 85%) as well as for stoma construction (up to 65%) and stoma closure without adding to the risks of postoperative morbidity, wound-related morbidity, surgical site infection, hematoma, wound disruption, postoperative mortality, chronic pain and length of hospital stay; and is cost-effective [30-33]. However, there is no evidence to support the use of biologic/biosynthetic meshes for this purpose [34-36]. Retro-muscular and onlay, both positions of a prophylactic mesh

seem equally effective and safe for closure of midline laparotomies. Incidence of stoma related IHs can be as high as >50%, prompting the evolution of guidelines and special techniques for using prophylactic mesh in stoma creation for both open and laparoscopic techniques [37-39]. Polypropylene prophylactic mesh placement patients are at increased risk for seroma; however, glue fixation of mesh can overcome the problem of seroma formation [40].

### Special incisions/ techniques for prevention of IH

Change of conventional hockey-stick incision for Renal Transplantation to the smallest possible semilunar line incision in the inguinal region aids in preventing post-transplantation incisional hernias [41]. A meta-analysis has shown that extra-peritoneal colostomy leads to a lower rate (6.3% versus 17.8%;  $p < 0.001$ ) of para-stomal hernia, as compared to trans-peritoneal colostomy [42]. But a randomized trial assessing the outcome of lateral para-rectus abdominis compared with trans-rectus abdominis muscle stoma placement in patients with temporary loop ileostomies did not show any difference in their para-stomal hernia rates [43]. Special techniques have been described for placement of a pelvic mesh to prevent perineal hernia after any abdomino-perineal resection of rectum [44].

Three time-honored techniques used for prevention of IH for years - abdominal binders after laparotomy, restrictions on physical activity after laparotomy, and use of retention sutures - but no scientific benefit/ evidence has been found for their use [45-47].

### Special risks for IH with different operations

The overall incidence of IH for Inflammatory Bowel Disease operations has been shown to be 21% for ulcerative colitis and 20% for Crohn's disease. Statistically significant risk factors for development of IH were same as for other operations, except the addition of age at the onset of disease [48]. The incidence of IH in children is significantly lower than that in adults, with comparable IH incidence with open and laparoscopic procedures; except increased risk for operations in neonates, laparoscopic fundoplication and open supraumbilical pyloromyotomy [49]. A study based on Swedish Colorectal Cancer Registry has shown the cumulative incidence of incisional hernia as 5.3% after 5 years of surgery; the risk factors were same as mentioned (*vide supra*) [50]. Another study has found the incidence at 13% out of 4579 colon resections [51]. Incidence of IH in cases of 'open abdomen' is high and reaches up to 65%.

Extrapolation of preventive options which have been shown effective in giant ventral hernia repair (including Component Separation Techniques, prophylactic negative pressure wound therapy, synthetic mesh reinforcement and use of Botulinum Toxin Type A to aid in abdominal wall reconstruction) might work effectively in this patient cohort with open abdomen as well [52]. The rate of IH after abdominal cancer operations is high and incidence varies for different diagnoses: urologic/gynecologic (30%), colorectal (53%), and all others (56%); but with similar risk factors [53]. IHs are common due to postoperative

immunosuppression following abdominal organ transplant with nearly one in five patients developing an incisional hernia 5 years after liver or pancreas transplantation. On multivariate analysis, SSI was strongly associated with hernia formation in all groups and its prevention and efficient treatment should be a priority in trying to prevent IH [54].

### Fascial dehiscence/burst abdomen

Another significant factor is fascial dehiscence/ burst abdomen, which is almost invariably followed by IH; regardless of suture material, technique of repair or application of retention sutures. This requires improvement in technique for repairing a burst abdomen. Fascial dehiscence and IH have similar causative factors; but fascial dehiscence occurring within 2 weeks of emergency surgery reflects more about the patient related factors (anemia, hypoproteinemia, intraabdominal sepsis, post-operative abdominal distention, chest infection etc.) while IH occurring much later is more reflective of abdominal closure technique.

### Identification of high-risk cases and centralized care

Risk prediction models have statistically combined significant risk factors to identify high risk patients preoperatively and these have been validated externally [55]. Perhaps the time has come to have centralized care for high risk cases to prevent the formation of IH.

### Safety of synthetic mesh in presence of infection and strangulation

Evidence is accumulating that a synthetic mesh can be safely used in the presence of perforation peritonitis and strangulated bowel [56-60]. The incidence of infection may be high, but the morbidity is acceptable and mesh removal is rarely required [60]. This favorable resistance of the non-absorbable synthetic structure of the polypropylene mesh to infections can be explained by the macro-porous structure of the mesh with pores of diameter larger than 70 microns, which allows contact of bacteria (measuring 1 micron in diameter) with granulocytes and macrophages (diameter of 15-20microns). This facilitates recovery from infections, and results in a high resistance rate to infections [61].

It has been shown in an animal model that there was no persistent inflammation in the contaminated field when the mesh was properly implanted, i.e., spread flat to create a more favorable condition for the penetration of the immune system. Bending or folding the mesh resulted in the creation of dense texture "dead spaces", making it difficult for immune cells to penetrate and leading to the persistence of the inflammatory process. This observation leads to the conclusion that many infections that are related to synthetic materials may be the result of a poor surgical technique [62].

### Recent experimental work

Recent animal experimental research has focused on strengthening of mesh; meshes surface modifications for reducing the adhesive properties to prevent bowel adhesions and

addition of controlled antibiotic delivery systems for Rifampicin and Gentamycin to prevent implant infections [63-66]. Other experiments include development of stronger suture material (polyurethane), and mesh derived sutures (for better resistance against suture cut-through) for abdominal closure [67,68]. Recently biomarkers (proteins assays associated with wound healing, advanced glycation end products/ collagen cross links) have been shown to predict personal hernia risk prior to undergoing an operation; if validated, tests for these can be included in hernia prediction models [69,70].

## Conclusion

Research workers have often lamented about the heterogeneity of patient cohorts, different surgical techniques, different imaging techniques for diagnosis and different follow up periods while reviewing available literature on prevention of IH. But evidence is accumulating that lightweight macro-porous synthetic mesh can be safely used without additional morbidity even in the presence of perforation peritonitis and strangulated bowel; prompting proponents to argue that prophylactic synthetic mesh augmentation should become the standard of care for high-risk patients undergoing midline laparotomy. Although Surgeons have always embraced new technologies; they seem surprisingly slow in using the option of prophylactic mesh augmentation in preventing IH. Fears of seroma formation, foreign body sensation and infection related morbidity are grossly over estimated and easily outweigh the advantage of preventing IH. Now that it is possible to identify high risk patients for development of IH, high quality evidence is available for its prevention and the preventive measures do not require expansive resources; time has come to overcome ingrained bias and convert available knowledge to implementation.

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