Laparoscopic versus open incisional hernia repair: An institutional experience

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***Abstract*- L**aparotomy performed for surgical access usually heals quickly and without complications, leaving a stable scar. An exception to this is the rare (< 1%) occurrence of acute separation of the sutured abdominal walls during the postoperative phase – known as acute wound dehiscence or burst abdomen – and the more frequent (> 20%) occurrence of chronic wound dehiscence with the formation of a hernial sac and canal months to years after surgery. This is known as incisional hernia. Incisional hernia is receiving greater attention in the medical community than in previous years, due to the increasing use of ultrasonography as part of follow-up after abdominal surgery, increased long term survival even after oncological surgery, and demographic developments which permit longer follow up.
Incisional hernias and ventral hernias larger than 2 cm are preferably repaired using prosthesis, because primary repair has an unacceptable high rate of recurrences.

Mesh repair has become standard for treatment of hernia now. With evolution of technology and the recent advances in surgery, surgeons started doing laparoscopic repair in 1990's.

The laparoscopic technique is believed to have fewer complications and a better postoperative course, with quicker ambulation, shorter hospital stay and less postoperative pain. Low recurrence rates of 0 to 9% are reported.

With the potential advantages of this minimal invasive approach, we started to perform this technique in our institute from 2008. This study was done to evaluate the results of our initial experience with laparoscopic repair and comparing with open repair of incisional hernia.

***Index Terms*-** Laparoscopic incisional hernia repair, open incisional hernia repair, mesh repair, minimally invasive incisional hernia repair.

I. INTRODUCTION

Incisional hernia has been clinically defined as "a bulge, visible and palpable when the patient is standing, and often requiring support or repair".

Incidence

Incisional hernia is a common and often debilitating complication after laparotomy.Despite significant advances in many areas of surgery, correction of incisional hernias continues to be problematic, with recurrence rates ranging from 5% to 63% depending on the type of repair used [1].Recurrence rates are likely underestimated because of a lack of long-term follow up and objective criteria in the literature to determine true recurrence.It is the most common complication after laparotomy by a 2:1 ratio over bowel obstruction and is the most common indication for reoperation by a 3:1 ratio over adhesive small bowel obstruction.
In a retrospective review of 206 patients who underwent incisional hernia repair, Read and Yoder [2] found that strangulation or incarceration was the indication for repair in 17% of patients. Incisional hernias are the only abdominal wall hernias that are iatrogenic.

PATHOPHYSIOLOGY

Advances in the basic and clinical sciences have allowed a better understanding of the pathophysiology of hernia formation. It is known, for example, based on Pascal's principle of hydrostatic forces and the law of LaPlace, that a hernia will continue to enlarge over time if not treated.

Increased intra-abdominal pressure will exert its greatest force on the portion of the wall that is thinnest. As the hernia enlarges, the wall thins at that point, and the diameter increases. This positive feedback loop virtually assures continued progression.

This is the reason, an incisional hernia is considered an indication for operation as in spite of its size as it eventually enlarges in size over a period of time due to continuous abdominal pressure on repeated straining. These complications will eventually be difficult to manage during an emergency surgery.

PREVENTION

Controversy exists regarding the optimal closure material and technique used to avoid incisional hernias. Carlson and colleagues [3] compared the incisional hernia rate of midline, transverse, and paramedian incisions. Midline incisions had the highest hernia rated 10.5% compared with 7.5% with transverse incisions and 2.5% with paramedian incisions.

In addition to incision type, the abdominal wall closure method is important for prevention of incisional hernias. A number of meta-analyses have shown that mass closure with a continuous non- or slowly absorbable suture is the best technique for preventing incisional hernias [4].

Although there is no strong evidence from randomized clinical trials, prospective clinical studies and experimental evidence support the use of a suture length : wound length ratio of at least 4:1. To arrive at a closure suture length of four times the incision length, the bites must encompass one centimeter of tissue at one-centimeter intervals. They also found non-absorbable suture in continuous fashion to be the material and technique of choice.

RISK FACTORS & ETIOLOGY

Studies have shown that 50% of hernia recurrences are detected in the first postoperative year, 75% are detected at 2 years, and 90% are detected at 3 years, with continued failure rates of 2% per year thereafter [5].

These findings implicate technical factors in early wound failure and patient-related factors in late wound failure.

Early wound failure – (Technical factors)

Playforth and colleagues [6] applied radiopaque staples to the margins of incised fascia. Serial radiographs were taken at time intervals up to 1 year. In patients who developed incisional hernias at 1 year, there was separation of the staples at 1 week postoperatively. This finding supports faulty surgical technique as the primary cause of early wound failure. Poole [7] concluded in a comprehensive review that local technical factors were of greater significance than patient-related conditions in the development of incisional hernias.

Given these findings, it is incumbent on surgeons to identify and use appropriate techniques and materials to minimize the incidence of incisional hernias.

Perioperative surgical site occurrence (SSO) defined as infection, seroma, wound ischemia, and dehiscence, increases the risk of recurrent hernia by at least 3-fold.

Controversy exists regarding the optimal closure material and technique used to avoid incisional hernias which was briefly discussed earlier under prevention.

Late wound failure – (Patient related factors)

Many patient-related risk factors have been implicated in the development of incisional hernias, including obesity, smoking, aneurismal disease, chronic obstructive pulmonary disease, male gender, malnourishment, corticosteroid dependency, renal failure, malignancy, and prostatism.

Many of these risk factors may contribute to the development of an incisional hernia, but no single factor is so regularly associated that it may be declared as serving a truly etiologic role.

Significant demographic factors influencing incisional hernia incidence were age (> 45 years) and male gender. The preoperative factors, anemia (Hb < 10 gm%) and BMI > 25 Kg/m^2, the intraoperative factors, recurrent incision and previous laparotomy, and the postoperative factors, catecholamin-therapy and disturbed wound healing were of significant influence in development of incisional hernia.

On multivariate analysis, only the combination of reopening and reclosing previous incisions coupled with wound infection influenced the development of incisional hernia.

Postoperative wound infection has been found in additional studies to be the single most significant prognostic factor in the development of incisional hernia.

Bucknall and colleagues [8] reported a 23% incidence of incisional hernia formation in patients who developed a wound infection.

CLASSIFICATION – EHS
(European Hernia Society) – 2007 [9]

This classification may provide enough information to establish incisional hernia registries and may be used to compare studies on treatment and outcome of incisional hernia repair. It has shortcomings, because of the large diversity and heterogeneity of incisional hernias, but it is a mandatory condition to improve the quality of reporting results in the field of incisional hernia surgery. There was a consensus that the following 2 criteria of incisional hernia are essential for classifying-

A) Localization of the hernia
B) Size of hernia defect

The abdomen was divided into a medial or midline zone and a lateral zone.

Medial or midline hernias

The borders of the midline area are defined as:
(1) cranial: the xyphoid
(2) caudal: the pubic bone
(3) lateral: the lateral margin of the rectal sheath

Thus, all incisional hernias between the lateral margins of both rectus muscle sheaths are classified as midline hernias.

An easily memorable classification from M1 to M5 going from the xiphoid to pubic bone was proposed (Figure 1). Therefore, we define 5 M zones:
(1) M1: subxiphoidal (from the xiphoid till 3 cm caudally)
(2) M2: epigastric (from 3 cm below the xiphoid till 3 cm above the umbilicus)
(3) M3: umbilical (from 3 cm above till 3 cm below the umbilicus)
(4) M4: infraumbilical (from 3 cm below the umbilicus till 3 cm above the pubis)
(5) M5: suprapubic (from pubic bone till 3 cm cranially).

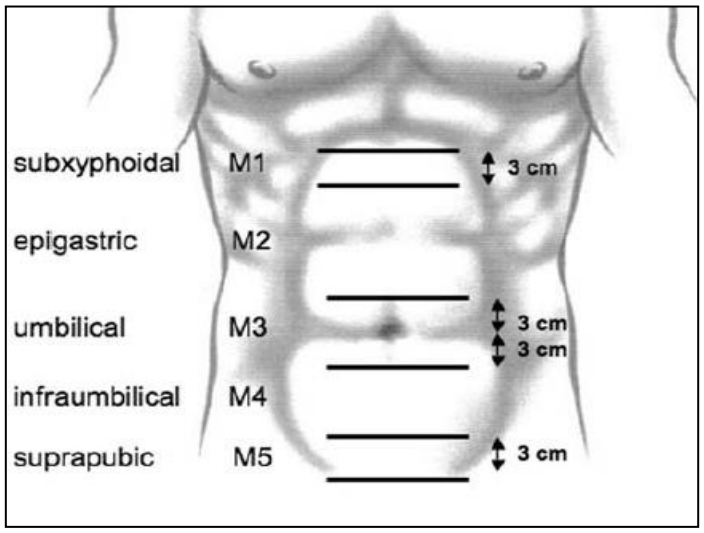


Figure 1 **:** Classification of midline incisional hernias

Lateral hernias

The borders of the lateral area are defined as (Figure 2).
(1) cranial: the costal margin
(2) caudal: the inguinal region
(3) medially: the lateral margin of the rectal sheath
(4) laterally: the lumbar region.

Thus, four L zones on each side are defined as:
(1) L1: subcostal (between the costal margin and a horizontal line 3 cm above the umbilicus)
(2) L2: flank (lateral to the rectal sheath in the area 3 cm above and below the umbilicus)
(3) L3: iliac (between a horizontal line 3 cm below the umbilicus and the inguinal region)
(4) L4: lumbar (latero-dorsal of the anterior axillary line)

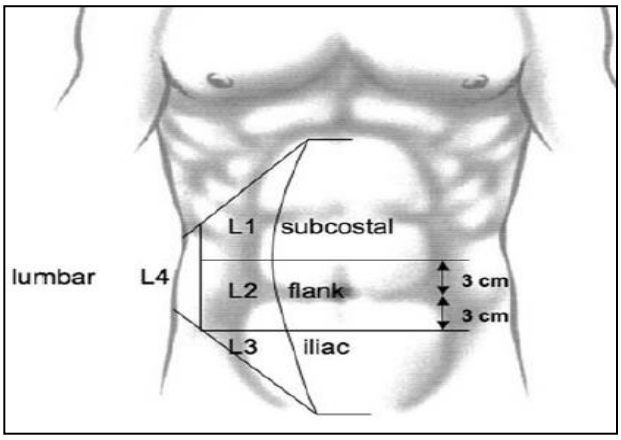


Figure 2 : Classification of lateral incisional hernias

Size of the hernia

In contrast to primary abdominal wall hernias, incisional hernias come in many different sizes and shapes. So the size of an incisional hernia is not easily captured in only one variable or measurement.

Chevrel solved this problem by choosing the width of the hernia defect as the one parameter to classify, stating that the width is the most important measurement of size to determine the difficulty of successfully repairing the hernia.

To avoid confusion with primary abdominal wall hernias (small, medium and large),a coded taxonomy was chosen instead of a nominative one.

W1< 4 cm;
W2 >= 4–10 cm;
W3 >= 10 cm

The length of the hernia defect was defined as the greatest vertical distance in cm between the most cranial and the most caudal margin of the hernia defect. In case of multiple hernia defects from one incision, the length is between the cranial margin of the most cranial defect and the caudal margin of the most caudal defect (Figure 3).

Hernia defect surface can be measured by combining width and length in a formula for an oval, thus trying to make an estimation of the real surface in cm^2. This option was not withheld, because many incisional hernias are not oval shaped, and many hernias have multiple defects, making the correct estimation of hernia defect size difficult.

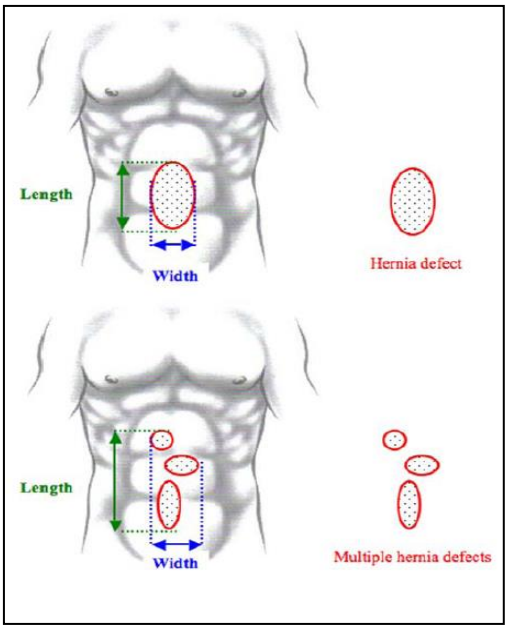


Figure 3 : Definition of the width and the length of incisional hernias for single hernia defects and multiple hernia defects

Table 1 : EHS Classification

E H S Incisional Hernia Classification			
Midline	subxiphoidal	M1	
	epigastric	M2	
	umbilical	M3	
	infraumbilical	M4	
	suprapubic	M5	
Lateral	subcostal	L1	
	flank	L2	
	iliac	L3	
	lumbar	L4	
Recurrent incisional hernia?		Yes O	No O
length:	cm	width:	cm
Width cm	W1 <4cm O	W2 ≥4-10cm O	W3 ≥10cm O

SIGNS & SYMPTOMS

Important symptom is bulge, which is located over or near the scar of a ventral abdominal wall incision and enlarges during standing, is the usual clinical presentation. In time, incisional hernias become larger.

In a literature review concerning the natural course of incisional hernia, this lack of information was underscored. According to this review, many incisional hernias (47-88%) are asymptomatic. In this review, strangulation or incarceration in incisional hernias was mentioned as an indication for operation in 6-14.6% of cases. Trophic ulcers were observed in 3.25% of giant incisional hernias (33 out of 1018 cases) [10].

Courtney described the presentation of 60 incisional hernias, of which 82% were primary incisional hernias [11]. The indications for operation in this study were pain in 83%, incarceration in 5% and enlargement in 3% of cases. In 3% of these patients, the indication for operation was not specified.

IMAGING

Sonography is a helpful diagnostic aid, particularly in small or barely palpable hernias, or in obese patients, as it is non-invasive, time and cost-saving, readily repeatable, and practically risk-free.

Besides location and size, ultrasonography allows the determination of hernial content, as well as excluding important differential diagnoses such as lymphoma or hematoma.

Important sonographic criteria for identifying hernias are:

- ✓ detection of a fascial gap (rectus diastasis as differential diagnosis),
- ✓ visualization of hernia content,
- ✓ increase in the volume of the hernial content and canal on Valsalva maneuver
- ✓ most commonly used for identification of early recurrence.

Computerized tomography or magnetic resonance imaging are methods particularly suited for complicated hernias or large abdominal wall defects and enable the visualization of internal hernial sac structures and the entire abdominal wall as well as their relationship to intra-abdominal organs.

TREATMENT & OUTCOME

Controversy exists regarding the ideal treatment of incisional hernias. Nowhere in surgery does the phrase ‘‘if there are multiple ways of fixing a problem then there is not one good way’’ hold true more so than with incisional hernia repair.

The approach to incisional hernia repair is often based on tradition rather than evidence.

In general, an incisional hernia is considered an indication for operation, but some surgeons prefer a wait-and-see policy.

Several important principles have been defined to aid in the surgical approach to this difficult problem.

The goals of hernia repair should be as follows:

1. Prevention of visceral eventration
2. Incorporation of the remaining abdominal wall in the repair
3. Provision of dynamic muscular support
4. Restoration of abdominal wall continuity in a tension-free manner.

The surgeon can choose from a number of treatment options, which fall into two principal categories:

- ✓ the conventional suture technique
- ✓ the open or laparoscopic mesh technique.

Surgical technique of open hernia repair –

The open technique may consist of a anatomic repair, simple hernioplasty (e.g., Mayo duplication or fascia adaptation), components separation technique or mesh repair.

The mesh can be placed using

- ✓ Onlay (prefascial/subcutaneous, Sandwich or Chevrel technique),
- ✓ Sublay (retromuscular or preperitoneal) or
- ✓ Inlay (“bridging”) techniques.

Open surgical techniques were popularized by Rives, Stoppa and Wantz.

Anatomical Repair :

Small hernial defects usually < 3 cm are closed primarily using non absorbable suture.

Retromuscular / Preperitoneal (Sublay technique) repair :

Rives developed the sublay technique. Medial border of the anterior fascia opened, posterior aspect of rectus muscle dissected to reach lateral border of rectus sheet, bilaterally. Peritoneum and posterior rectus fascia closed with absorbable suture. Polyester or light-weight polypropylene mesh is cut to fit the reconstructed area, to have 3 cm overlap on caudal and cranial defect limits. Mesh is fixed by non-absorbable sutures. Anterior fascia is closed with non-absorbable suture. Components separation upon need was done.

Recent advocates of the technique have claimed that sublay is the ideal position for the mesh, but have not provided evidence from randomized trials.

The disadvantages of the sublay are that it is more technically challenging, requiring the opening of a large space behind the rectus muscles. The sublay method is only applicable to midline hernias and cannot be used in other locations which represent 20% of anterior abdominal wall incisional hernias.

Onlay (Prefascial/Subcutaneous, Sandwich or Chevrel technique) repair:

The onlay technique was originally reported by Chevrel. Fascial defect is closed with interrupted or running non-absorbable suture. Mesh is placed and fixed over the closed rectus defect by using an intermittent non-absorbable suture. Components separation upon need was done.

When the prosthetic material is secured posterior to the abdominal wall musculature in the preperitoneal space or subpreperitoneal space, as described by Stoppa, an increase in intra-abdominal pressure buttresses rather than distracts the repair. Hence, sublay repair is said to be better with less chance of recurrences compared to onlay mesh repair.

Conversion to open surgery

The conversion rate to open surgery depends on the surgeons experience, the surgical skills, and intraoperative complications such as bowel lesions or bleeding.

In the literature conversion to open surgery is mostly due to adhesions, with an overall conversion rate of 10-15% [12]. However, complete adhesiolysis is very important especially in large incisional hernia to gain enough place for the mesh fixation and therefore to minimize the recurrence rate.

Laparoscopic Repair of Incisional Hernia -

The popularity of laparoscopic incisional hernia repair is increasing. The early postoperative adverse events, overall safety, and clinical effectiveness of laparoscopic and open repair are similar.

The laparoscopic approach offers several key advantages over the open approach, including low risks of infection and shortened hospital stay in addition to reductions in complication rates, postoperative pain, and postoperative ileus.

The lower recurrence rates reported with laparoscopy are convincing, although they remain to be demonstrated conclusively. Even lowered overall hospital costs have been associated with laparoscopic hernia repair.

Accessing the abdomen for a laparoscopic hernia repair and performing adhesiolysis does carry a potential risk of injury to intestine, which, if missed, can lead to intra-abdominal sepsis.

Itani and colleagues [13] have reported the rates of bowel injury as 7.2% in open hernia repairs and 9% in laparoscopic procedures. Others have reported that the incidence of bowel injuries differs insignificantly between laparoscopic and open approaches and is low in both approaches.

The bowel actually is easier to identify in laparoscopic surgery than in open surgery, because it generally hangs down, away from the abdominal wall, and insufflation permits better plane definition.

Transfixing sutures typically are used to facilitate close approximation of the prosthetic material to the abdominal wall so adequate ingrowth can occur. Persistent pain at these suture sites is a problem unique to the laparoscopic approach and occurs in 1% to 3% of patients.

In a series by Olmi and colleagues [14] wound complications also were noted to be significantly lower in laparoscopic hernia repairs than in open repairs (1.1% versus 8.2%). The laparoscopic approach diminishes the need to raise large tissue flaps or devitalize tissues, procedures that increase the risk of mesh infection.

Consideration must be given to the use of carbon dioxide as the insufflation agent during laparoscopy. The additional carbon dioxide burden is a contraindication to laparoscopic herniorrhaphy for patients who have severe chronic obstructive pulmonary disease. Because even a relatively modest increase in afterload or decrease in preload would prove problematic, patients who have extremely poor cardiac reserve may be better served by an open approach or watchful waiting.

II. MATERIAL AND METHODS

This study is a prospective observational study, conducted from 15-Nov-2011 to 15-April-2013 including all the patients of incisional hernia operated in Kasturba Hospital, Manipal within the study period fitting into the study requirements according to inclusion and exclusion criteria as mentioned below.

Inclusion Criteria

1. Age:->18 years
2. Uncomplicated incisional hernias reducible hernias only
3. Diagnosed case of incisional hernia (Imaging/Laparoscopy)
4. Medically fit for general anesthesia

Exclusion Criteria

1. Age <18 years
2. Obstructed hernia / Incarcerated hernia
3. Emergency surgery, peritonitis, bowel obstruction, strangulation, perforation
4. Incisional hernia repair accompanied with any other surgical procedure
5. Cases of other ventral hernias (epigastric , umbilical / paraumbilical, spigelian hernias)
6. Ongoing chronic pain syndrome, other than hernia origin
7. Mentally ill patients/Any cognitive impairment (Psychiatric disorder, Alzheimer's disease etc.)
8. Presence of local or systemic infection.

Sample size (N) under the study after excluding the cases was 173 (time bound study) within the study period, out of which 89 cases underwent laparoscopic repair and 84 cases underwent open repair out of which 9 cases were converted from laparoscopic to open repair.

- Institutional Ethical Committee approval to conduct the study was obtained prior to the commencing enrollment of patients. Written and informed consent was obtained from all the patients who participated in the study.
- Data on these patients were collected with use of a standard proforma on which were recorded age, sex, previous operation, preoperative evaluation, hernia size and location, previous hernia repairs, operating time, intraoperative and postoperative complications, postoperative hospital stay, date of last follow-up evaluation, and whether there had been a hernia recurrence.
- Choice of laparoscopic and open hernia repair for incisional hernia is left to choice of patient and the concerned attending consultant.
- Post operative pain, hospital stay, complications and followup were measured statistically according to the final type of repair done for the incisional hernia i,e; 80 laparoscopic repair and 93 open repair as 9 cases were converted from laparoscopy to open repair.
- Post operative pain is recorded at POD-1 and POD-3 using Verbal Numerical Rating Scale (VNRS) from 0 to 10 with 0 being no pain and 10 being maximum (worst pain ever in their life).
- Patients were followed up for minimum period of 6 months post operatively.
- Statistical analysis was done using IBM SPSS Statistics version 21.
- P-value were calculated using Independent sample t-test (parametric variables) and Mann Whitney's test (non-parametric variables).

Open mesh technique :

After taking patients to operative theater and under general anesthesia, endotracheal intubation was done and operation was started. Foleys catheter was put for patient with lower abdominal ventral hernia repair and nasogastric tube for

upper abdominal hernia repair with perioperative single dose of prophylactic antibiotic.

Then after proper cleaning, painting and draping of abdomen the skin incision made according to site and size of defect, subcutaneous flap raised up to 3 to 5 cm around the defect, the hernial sac found, contents reduced back then posterior rectus sheath and muscle dissected and between rectus muscle and peritoneum in lower abdomen .posterior rectus and peritoneum closed primarily with 2:0 absorbable suture, then polypropylene mesh of suitable size with minimum of 3 cm overlap beyond the margin of defect is placed over posterior rectus sheath / peritoneum and rectus muscle or above the repaired defect depending on the type of mesh repair (Figure 4).

Mesh is then fixed in four corners with 2:0 propylene sutures and taken out through abdominal muscle on the anterior rectus sheath, anterior rectus sheath closed over the mesh with a loop of polypropylene or nylon without tension, then skin closed over the drain/drains depending upon size and extension of the wound .

Figure 4 : Intra operative image showing preperitoneal mesh fixation

Surgical technique of laparoscopic hernia repair -

Pneumoperitoneum was established with use of a Veress needle inserted in either the left or right subcostal space. A direct view trocar was inserted laterally in a window between the iliac crest and costal margin. A 30- degree or 45-degree 5- or 10-mm laparoscope was used. Most hernias could be repaired with 1, 10-mm and 2, 5-mm ports placed laterally in the upper and lower quadrant, respectively. Adhesiolysis was performed, and the margins of the defect were clearly delineated (Figure 5).

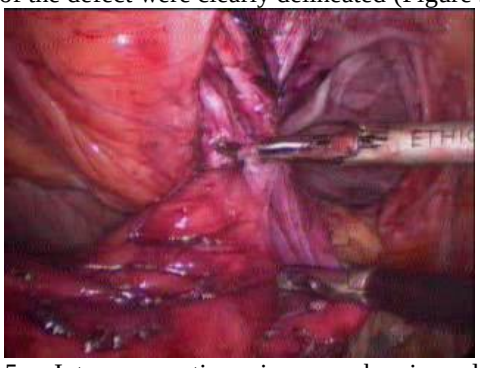


Figure 5: Intra operative image showing laparoscopic adhesiolysis and reduction of hernial sac

The hernia sac was not opened or dissected free. In general, the hernial sac is left in situ (Figure 6). After completion of adhesiolysis, the pneumoperitoneum is released, the maximal longitudinal and horizontal hernia diameter is measured and marked on the skin. An appropriate sized mesh is tailored in order to overlap the hernia margins by at least 5 cm on each side. In addition, the mesh should overlap the full length of the incision of the primary operation.

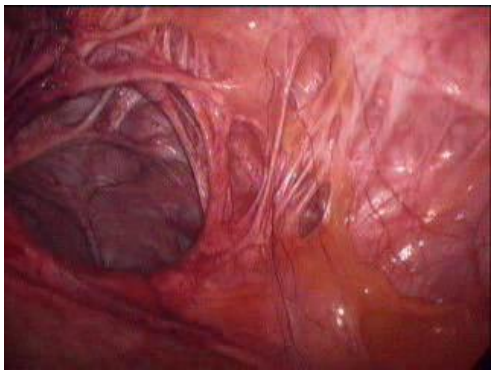


Figure 6: Intra operative image showing hernial defect after reducing the sac

There are 2 types of laparoscopic mesh used for laparoscopic repair in our institute, LOTUS (DUAL mesh) and PHYSIO (Flexible Composite mesh) mesh. Non absorbable monofilament sutures are present at corners along the mesh for LOTUS mesh (Figure 7).

The mesh is rolled up and inserted into the abdomen through a 12mm trocar. Then the mesh is rolled up and introduced into the abdominal cavity. After the mesh is positioned correctly in the abdominal cavity, the suture ties are pulled through the abdominal wall with a suture passer (epidural needle) and the threads are knotted smoothly with the knots buried in the subcutaneous tissue after reduction of the intraabdominal pressure to 8mmHg for LOTUS mesh.

We use absorbable tackers that are applied every 1 to 2 cm all around the hernial orifice and along borders of the mesh. Hemostasis is secured and ports are removed. Port closure done and tight pressure bandage applied to prevent post op seroma formation as the hernia sac is left in situ.

Figure 7: Inta operative image showing insitu LOTUS (dual) mesh

III. OBSERVATIONS & RESULTS

173 patients underwent incisional hernia repair within the study period of 18 months, out of which 89 cases underwent laparoscopic repair and 84 cases underwent open repair of incisional hernia.

9 out of 89 laparoscopic cases were converted to open procedure, out of which 2 cases were diagnosed to have incisional hernia defect after a diagnostic laparoscopy for chronic pain abdomen with normal imaging and an anatomical repair was done for both of the cases, rest of the 7 cases were converted due to dense adhesions.

Post operative pain, hospital stay, complications and followup were measured statistically according to the final type of repair done for the incisional hernia i,e; 80 laparoscopic repair and 93 open repair as 9 cases were converted from laparoscopy to open repair.

Mean age of patients in our study was 50.26 SD $^{+}$ 12.32 years, the youngest being 24 years and oldest being 80 years (Table 2). Out of 173 (N) patients in our study there were 40 (23.12%) males and 133 (76.88%) females showing a Male to female ratio of incisional hernia of 1 : 3.3 in our study.

Table 2 : Age distribution in the study population

	Range of Age (years)	Mean Age (years)	S.D
Laparoscopic	27-80	50.25	11.642
Open	24-76	50.27	13.076
Total	24-80	50.26	12.323

Previous surgeries which the patients underwent are shown in the (Table 3) as above in which laparotomy cases were separated as clean and infected cases. Peptic ulcer surgery (Gastrojejunostomy + Vagotomy), Retroperitoneal / Non bowel tumor (lymph nodal mass) excision or biopsy, cystogastrostomy and elective bowel resection were considered as clean cases and emergency surgeries with perforation peritonitis or bowel gangrene and elective surgeries with post op wound infection were considered as infected cases. Other cases mentioned in the pie chart were CABG(1) , open nephrolithotomy(1), open prostatectomy(1), stoma (ileostomy/colostomy) closure site(2) and lumbar sympathectomy(1),drain site hernia(2). Two incisional hernia cases presented post trauma after bull gore injury.

Fifteen patients out of 173 presented with recurrent incisional hernia which was operated at outside hospital previously.

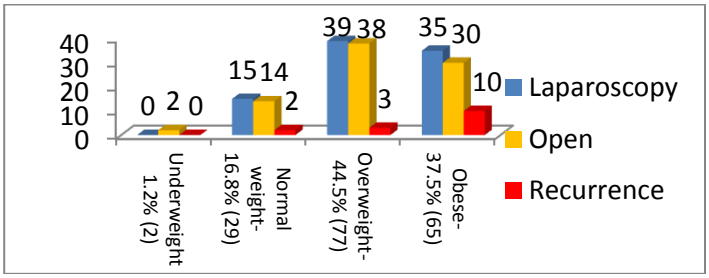
114 (65.9%) patients had presented with swelling over the abdominal wall alone and 32 (18.5%) patients presented with chronic abdominal pain alone and 27 (15.6%) patients presented with both swelling and abdominal pain.

BMI (Body Mass Index) in relation to incisional hernia incidence and recurrence are shown in bar graph below (Graph 1). There are 15 patients who presented with recurrent incisional hernia out of which 13 were above normal of which 3 are overweight and 10 patients are obese.

Table 3 : Prior abdominal surgeries in the study population

Previous Surgeries	Number
Laparotomy (Clean)	26 (14.3%)
Laparotomy (Infected)	32 (17.6%)
Cholecystectomy	7 (3.8%)
Appendicectomy	4 (2.2%)
Splenectomy	1 (0.6%)
Totalabdominal Hysterectomy	44 (24.2%)
Cesarean Section	40 (21.9%)
Tubectomy	15 (8.2%)
Post-Traumatic Hernia	2 (1.1%)
Port Site Hernia	3 (1.6%)
Others	8 (4.4%)
Total (N)	**173**

Graph 1: BMI distribution in the study population



According to EHS (European Hernia Society) Classification depending on the site of hernial defect, hernias are divided into midline and lateral hernias. 130 (75.14%) midline hernias were further divided into 5 groups depending on site of defect and 43 (24.86%) lateral hernias which were subdivided into 4 groups which were shown in the table given below (Table 4). There were no cases of lumbar site hernia seen in our study.

Table 4 : Classification of incisional hernia according to EHS classification

EHS Classification	Laparoscopy	Open	Total (173)	%of Incisional Hernia
MIDLINE HERNIAS (M)				
M-1 (sub-xiphoidal)	2	3	5	2.89%
M-2 (epigastric)	4	7	11	6.36%
M-3 (umbilical)	22	16	38	21.96%
M-4 (infra-umbilical)	30	27	57	32.95%
M-5 (suprapubic)	10	11	21	12.14%
LATERAL HERNIAS (L)				
L-1 (sub-coastal)	5	3	8	4.6%
L-2 (flank)	1	2	3	1.7%
L-3 (iliac)	15	15	30	17.4%
L-4 (lumbar)	0	0	0	NA

Depending on the width of the hernia defect it is again classified into 3 groups as shown in table below according to EHS Classification. For small hernial defect of < 4 cm, 45 underwent laparoscopic repair and 48 underwent open repair and for large defects >10cm only 5 underwent laparoscopic repair out of which 3 were converted and 7 underwent open repair (Table 5).

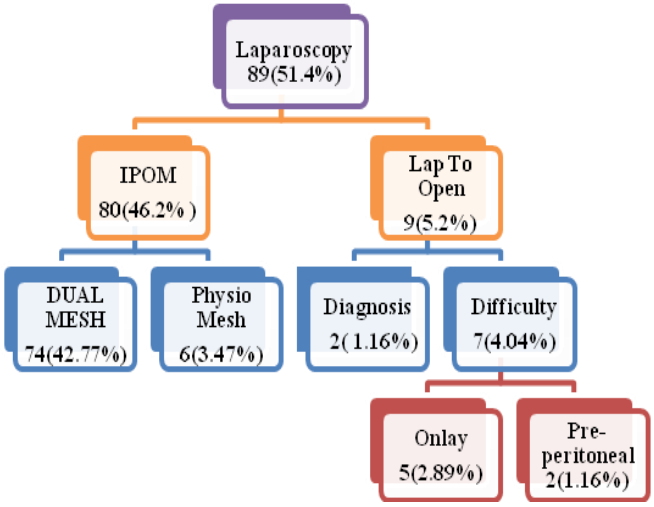
Table 5 : Hernial defect size in the study population

	Laparoscopy	Open	Total (173)
W-1 (<4cm)	45	48	93 (53.76%)
W-2 (>=4cm-<10cm)	39	29	68 (39.30%)
W-3 (>=10cm)	5	7	12 (6.94%)

Imaging modalities like Ultrasound and CT – Abdomen were done only in 47 (27.2%) patients and no pre operative imaging was done in 126 (72.8%) patients. Two cases were diagnosed after a diagnostic laparoscopy for chronic abdominal pain after undergoing imaging which was normal.

Eighty nine (51.4%) patients underwent laparoscopic repair out of which 9 cases were converted into open procedures in which 2 cases were diagnosed as incisional hernia on table and converted to open procedure in view of very small defect (<3 cm) where anatomical repair was done. Rest, 7 cases were converted due to dense adhesions to abdominal wall and difficulty in clearing adhesions laparoscopically (Flow chart 1).

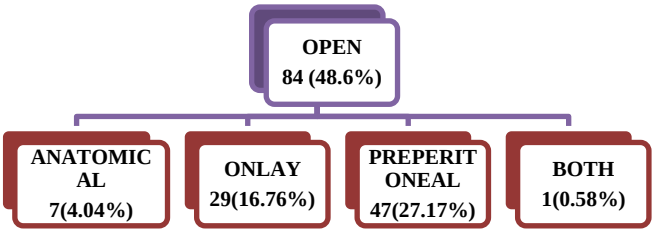
Flowchart 1 : Laparoscopic management of incisional hernia



Eighty four (48.6%) patients underwent direct open hernia repair which were again divided into anatomical, onlay and preperitoneal repair (Flowchart 2).

The choice of open and laparoscopy repair was left to the patient and consultant choice and no intervention was done in selecting the type of repair for the study.

Flowchart 2 : Open procedure for incisional hernia



Multiple hernia defects (Swiss-cheese pattern) are seen in 29.21% (26 out of 89 cases) of cases operated by laparoscopic method while 11.9% (10 out of 84 cases) of them are detected in case of open incisional hernia repair.

The mean of size of hernial defect in laparoscopic repair is about 15.39 cm^2 with S.D of 11.942 while it is about 19.44 cm^2 with S.D of 29.092.

The mean duration of surgery for laparoscopic repair is 125.67 minutes with S.D of 49.274 and for open repair it is about 118.45 minutes with S.D of 43.45.

There is no significance in P-value calculated for duration of surgery and defect size.(Independent t-test) (Table 6).

Table 6 : Duration of surgery and defect size in the study population

	Laparoscopy Mean(Range)	Open Mean(Range)	P-value
Duration of surgery(min)	125.67 (60-300)	118.45 (60-330)	0.936
Defect size (cm^2)	15.39 (4-60)	19.44 (2-160)	0.998

Post operative pain, hospital stay, complications and follow up were measured statistically according to the final type of repair done for the incisional hernia i,e; 80 laparoscopic repair and 93 open repair as 9 cases were converted from laparoscopy to open repair.

Post operative pain is calculated at POD-1 and POD-3 using pain scale grading from 0 to 10 for both the groups. Mean pain value at POD-1 for laparoscopic repair is 3.72 +/- 0.953 and open repair is 4.4 +/- 0.907 while mean pain value at POD-3 for laparoscopic repair is 1.38 +/- 1.061 and open repair is 2.4 +/- 0.808.

Post op hospital stay for the patients in both groups is compared by calculating mean duration of stay which is about 5.28 days (S.D +/- 2.509) in laparoscopic group and 8.57 days (S.D +/- 4.163) for open repair group.

P-values are calculated using Mann-Whitney Testand independent sample T – testwhich showed significant value of < 0.001 (Table 7).

On gross outlook post op complication for both laparosopic and open repair are high and alarming (Table 8,9).

Post op complications of both procedures are compared and laparoscopic repair showed complications in 31.25% (25 out of 80) of cases.

However most of the complications are minor and did not require any intervention and was managed conservatively.

Only 13.75% (11 out of 80) required hospitalization for management of complications in laparoscopic repair. Open repair on total showed complication rate of 36.56% (34 out of 93 cases) and among which some of them are managed conservatively without hospitalization but in spite of which 27.96% (26 out of 93) of complications required hospitalization. Wound related complications are only 4 (5%) in case of laparoscopic repair while it is about 19 (20.4%) in case of open repair.

Recurrence rate for incisional hernia operated in our hospital were 3 out of 80 (3.75%) in case of laparoscopy and 4 out of 93 (4.3%) in case of open repair.

Out of the 4 open recurrence cases 1 was converted from laparoscopy to open due to dense adhesion and an open repair was done for it.

Table 7 : Pain scale and Post operative hospital stay in the study population

	Laparoscopy (Mean/Range)	Open (Mean/Range)	P-value
Pain scale			
POD-1	3.7 (2-7)	4.4 (3-7)	< 0.001
POD-3	1.4 (0-4)	2.4 (1-4)	< 0.001
Post op hospital stay			
No of days	5.28 (1-13)	8.57 (3-30)	< 0.001

Table 8 : Complications in the study population

Complications		Laparoscopic Repair (89 – 9 = 80)	Open repair (84+9=93)
Local complications			
1	Wound infection (SSI)	4	12
2	Flap necrosis	0	7
3	Seroma	6	5
4	Hematoma	2	0
5	Suture granuloma	1	0
6	Mesh infection	0	1
7	Mesh migration	1	0
8	Prolonged ileus	4	2
9	Bowel injury	0	1
Systemic complications			
1	Pulmonary Complications	3	0
2	Cardiac Complications	0	0
3	Genitourinary Complications	0	0
4	DVT	1	2
Recurrence		3 (3.75%)	4 (4.3%)
Total Complications		25 (31.25%)	34 (36.56%)

Table 9 : Complications in the study population

	Laparoscopic repair	Open repair
Wound related complications	5% (4)	20.4% (19)
Interventional Complications	13.75% (11)	27.96% (26)
Total Complications	32.5% (26)	35.5% (33)

Patients are followed up for minimum of 6 months and maximum of upto 23 months by follow up visits. 76.25% of patients came for follow up in case of laparoscopic repair with mean follow up time of about 5.22 months. 75.27% of patients came for follow up in case of open repair with mean follow up time of about 7.46 months (Table 10).

Table 10 : Follow up in the study population

	Laparoscopy	Open
Total patients	80	93
No follow-up	19	23
No. of follow-up patients	61 (76.25%)	70 (75.27%)
Mean time of follow-up (months)	5.22	7.46
Range (months)	6-23	6-23

IV. DISCUSSION

Obesity is a perhaps the most important factor, in the causation and recurrence of incisional hernias in this study. Incidence of incisional hernia is more as patient is obese showing 82.1% of cases of incisional hernia with above normal BMI. 87% of recurrent incisional hernias presented to us are above normal weight and out of which 67% are obese. Increased recurrence rates are also seen in the obese after repair of incisional hernias. However, obesity still poses an increase in both wound complications and recurrences rates, even using the laparoscopic approach. It is therefore desirable for patients to lose weight preoperatively if possible.

Characteristics of incisional hernia observed in our study are the presenting symptoms and site of hernial defect. Most of the patients of incisional hernia defect presented with swelling alone and no imaging is usually required as it is a clinical diagnosis.

Pre-operative imaging was done in 27.2% of the cases in our study, while some cases even though it was clinically evident imaging was done to rule out other causes of chronic pain abdomen other than incisional hernia.

Rodriguez et al. [15] found an incidence of 23% for abdominal wall hernias with CT scanning after open abdominal aortic aneurysm repair while only 8% of the patients had clinical evidence of an incisional hernia. Thus imaging may help in high risk patients of recurrence for its early detection and less perioperative comorbidity as they requires surgery eventually after a period of time. CT abdomen is a sensitive investigation compared to USG, while diagnostic laparoscopy is considered as a superior investigation from that of any imaging.

Most of the incisional hernias are midline hernias which are about 75.14% while remaining, 24.86% are lateral hernias. Very few of the incisional hernia studies were classified according to the site of hernial defect, one such study was Muysoms et al [9] where midline hernias account to 76.9% while lateral hernias account to 23.1% which is similar to our study findings.

In our study we found that although laparoscopic incisional hernia (Mean duration of surgery-125.7min) repair took longer time to perform than open repair (118.4min), while some studies by Asencio et al [19] and Barbaros et al [17] how a similar longer duration of laparoscopic surgery, some other studies like Misra et al [18] and Olmi et al [19] go against the study.

Range of the time for surgeries is around the same for both the cases in our study which is, minimum around 60 minutes and maximum around 300 minutes. Longer duration of laparoscopic surgeries in our study can be attributed to the learning curve of surgeons in our hospital and is due to difficulty in case due to dense adhesions and reducing the contents, all through laparoscopic approach. While some complex cases of open hernia repair were also time consuming in order to do repair by a pre-peritoneal approach. Most of the open cases were planned for pre-peritoneal repair unless otherwise complicated or if there was difficulty in creating the plane.

Conversion rate of laparoscopic repair into open repair in our study is about 5.2% (9 out of 89 cases) out of which 2 cases were diagnostic laparoscopies followed by open repair to prevent the cost of intrapertioneal dual mesh charge as consent was not taken for placement of a costly intraperitoneal dual mesh. Rest 7 cases were converted to open in view of dense adhesions and difficulty in reducing the contents laparoscopically in fear of bowel injury. The lack of expertise by the concerned operating surgeon in laparoscopic repair can also be attributed to the higher conversion rate in our study. McGreevy et al [20] study showed similar conversion rate of 4.6% (3 out of 65 cases) of the cases.

Our patients in the laparoscopic repair group had a shorter duration of hospitalization and probably faster recovery time than those in the open repair group. The mean of post op hospital stay in our study is about 5.3 days in case of laparoscopic repair and 8.6 days in case of open repair which was relatively very high when compared to other comparative studies, Pring et al [21] which is around 1 -3 days except in a study conducted by Olmi et

al which is about 2.7 days for laparoscopic repair and 9.9 days for open repair [19].

Longer duration of hospital stay when compared to other studies is mainly due to discharge of patient only after complete attainment of regular activity and also in some cases, because of insurance reasons.

Post-operative pain in our study is calculated on POD -1 and POD-3 using Verbal Numerical Rating Scale (VNRS) in our study which showed significant decrease ($P < 0.001$) in laparoscopic surgery (POD-1 -3.7; POD-3- 1.4) compared to open surgery (POD-1 – 4.4; POD-3 -2.4). Main reason for selection of POD-3 timing is to eliminate the pain caused by tackers used in laparoscopic repair which pierces the parietal peritoneum and causes more pain in the immediate post op in case of laparoscopic repair. Some studies like Asencio et al [16] have shown increased post op pain in case of laparoscopic repair compared to open repair, this might be attributed to the trans parietal suturing along with the tackers which was used to fix IPOM. But most of the studies which had taken VNRS to compare post op pain showed decrease in post op pain in laparoscopic repair compared to open repair but has not showed statistical significance as in Barbaros et al [17] and Misra et al [18] study.

In this study fewer wound complications occurred in patients who underwent laparoscopic operation than in those who had an open procedure.

There are about 5% wound related complications in laparoscopic group compared to 20.4% in case of open repair group which is around 4 times more in case of open repair. These findings are similar to study conducted by Misra et al [18] where only wound related complications are specifically separated which is about 6% in case of laparoscopic repair and 33% in open repair of incisional hernia. In a series by Olmi and colleagues [19], wound complications also were noted to be significantly lower in laparoscopic hernia repairs than in open repairs (1.1% versus 8.2%).

There is 1 case of mesh removal done in open hernia repair because of mesh infection which was repaired by component separation while there is 1 case of mesh migration seen in laparoscopic repair for which again IPOM was placed laparoscopically. The cause of mesh infection is due to wider tissue plane dissection and prolonged surgery while that for mesh migration might be due to improper coverage of the henial defect using mesh. The site of the original incision had no influence on recurrence rate in the study by Hesselink et al [22].

More cases of prolonged ileus were observed in the laparoscopic repair group, 5% than in the open repair group, 2.2% in this study. This may have been because the condition was more evident in the quickly recovering patients in the laparoscopic group and was overlooked or under reported in patients in the open group, who had a more prolonged convalescence.

Hernia recurrence rates in our study were 3.75% in case of laparoscopic repair and 4.3% in case of open repair. However, we found that recurrence was associated with high BMI and wound complications. Recurrence rate in similar comparative studies are variable with 9.7% recurrence in case of laparoscopic repair and 7.9% recurrence in open reapir. While there is no recurrence seen in some studies like Navarra et al [23].

High BMI with recurrence is seen in 100% of cases in laparoscopic group and in 75% of cases of open group. (laparoscopic - 2 obese, 1 overweight and open recurrences -2 obese, 1 overweight).

Perioperative surgical site occurrence (SSO) defined as infection, seroma, wound ischemia, and dehiscence, increases the risk of recurrent hernia by at least 3-fold according to Sanchez et al [24]. Perioperative SOO causing recurrence in our study is 1.4 times than normal recurrences due to other factors.

Drawbacks of the study are, it is an observational study alone and no randomization was done regarding selection of comparable cases. Since all the surgeries have been performed by different surgeons of different caliber standardization could not be done. Even the type of repair in open type is not taken into consideration while analyzing post op complications and recurrence of hernia.

Overall cost effectiveness and mesh selection in both the procedures was not analyzed in our study, which is main limiting factor for choosing laparoscopic over open repair of incisional hernia.

To date, only a very few randomized trials exist [25,26] and comparative study cohorts if randomized are of very small study population mostly ($N < 100$). Larger population studies need to be done with better randomization of population for better analysis and reliable results from the study.

V. CONCLUSIONS

- Laparoscopic incisional hernia repair should be the first line of surgery for incisional hernia repair as there is less chance of post op wound related complications and morbidity as such if the patient is fit for general anesthesia.
- Obesity is perhaps the most important factor, in the causation and recurrence of incisional hernias and pre-operative weight reduction is very important pre requisite for success of laparoscopic hernia especially.
- Pre-operative imaging helps in early diagnosis of small incisional hernia in obese patients and also in identification of contents and their condition within the hernial sac. Role of imaging in incisional hernia repair need to be further evaluated in future studies.
- Laparoscopic repair is better for detection of multiple defects of incisional hernia compared to open repair.
- Post op pain , length of hospital stay and post-operative readmission are less in laparoscopic surgery compared to open repair.

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