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ORIGINAL ARTICLE

Laparoscopic ventral/incisional hernia repair: a single centre experience of 1,242 patients over a period of 13 years

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Abstract
Background and purpose Laparoscopic technique is now well established for ventral/incisional hernia repair. However several issues such as optimal fixation technique, occult hernias, management of inadvertent enterotomies, postoperative seromas and recurrence require appraisal.
Methods A single centre retrospective review of 1,242 patients between January 1992 and June 2005 is described. All patients had laparoscopic ventral/incisional hernia repair (LVIHR) following a standardised protocol by five consultants and fellows in a dedicated minimal access surgery unit of a tertiary care hospital.
Results LVIHR was completed in 1,223 patients (98.5%). The average BMI was 32, mean defect size was 26.2 cm^2, mean operating time was 81 min and mean hospital stay was 1.9 days. The mean mesh to hernia ratio was 37.5. Occult hernias were observed in 203 (16.3%) patients and inadvertent enterotomies occurred in 21 (1.7%) patients. Mortality occurred in two patients, pulmonary embolism and cardiac dysrhythmia being the respective reasons. The most common sequel was early seroma formation (25%). Chronic pain occurred in 14.7% patients. Recurrence rate was 4.4%, which was associated with a higher BMI, use of staplers as fixation device, multiple defects and recurrent hernias. The mean follow up was 5.4 years; (range 2.4–10 years). The follow up rate was 78%.
Conclusion LVIHR leads to low recurrence rates and low rates of wound and mesh infection. Occult hernias are diagnosed and optimally treated laparoscopically. However, chronic pain remains an unresolved issue.

Keywords Ventral hernia · Incisional hernia · Laparoscopic repair · Occult hernia · Chronic pain

Introduction

Many authors have consistently reported good outcomes with laparoscopic ventral/incisional hernia repair (LVIHR) [1–7]. However, although hernia recurrence rates, wound infection rates and mesh infection rates are low, several issues such as mechanism of recurrence, optimal fixation techniques and devices, occult hernias, management of inadvertent enterotomies and post-operative seromas still require appraisal. We reviewed our experience of more than a decade and 1,242 LVIHRs to analyse operative techniques and outcomes in an attempt to address the issues above.

Patients and methods

A total of 1,242 patients underwent LVIHR at our department between January 1992 and June 2005. All patients had LVIHR with intraperitoneal mesh except patients with suprapubic and lumbar hernias in whom the mesh was partially or completely extraperitoneal. We have previously

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reported our experience with LVIHR using a totally extraperitoneal approach in 34 patients with paraumbilical hernias [8] and these patients have been excluded from the present report. All procedures were performed by five consultants and fellows, following a standardised operative protocol. All patients with ventral/incisional hernia who were eligible for surgery were offered laparoscopic repair. The only exceptions were those who had very large hernias where a 5 cm overlap of the mesh was deemed not possible intra-abdominally, or patients with redundant skin and subcutaneous fat over the hernial site on the abdominal wall with marked loss of abdominal domain. Such patients were referred for an open abdominoplasty procedure with placement of an onlay mesh for hernia repair. The patients were counselled regarding the repair, biomaterial and the likely post-operative course, especially regarding seroma formation.

Operative technique

The technique of LVIHR involves placement of a prosthetic biomaterial in the sublay position (commonly referred to as intraperitoneal onlay mesh repair) and sometimes in the retro-muscular pre-peritoneal position (partially or completely extra-peritoneal mesh placement).

Operation theatre layout

The operating room layout was essentially the same as for laparoscopic cholecystectomy. The anaesthesia trolley was placed at the head end, the endovision equipment to the right of the patient and the instrument trolley at the foot end of the patient. The surgeon stands on the left of the patient with the assistant to his right and the scrub nurse to his left. The operating room layout was changed for suprapubic hernias, in which case the endovision equipment was placed at the foot end and instrument trolley to the left of the patient. This was done in accordance with the principle of surgeon, telescope, target area and monitor being located in a straight line for optimal ergonomics.

Patient positioning

The patient was placed supine in Trendlenberg position with left flank raised to ensure an ergonomically efficient position for the surgeon. An orogastric tube was routinely inserted before the initial peritoneal access. A urinary catheter was inserted only for hernias located infraumbilically.

Initial access

The initial peritoneal access was by a Veress needle puncture. The site of entry was at least 10 cm away from the hernia/previous scar. The most preferred site for initial access was Palmer's point—a point 2 cm below the left costal margin in the midclavicular line [9], where one is least likely to encounter intra abdominal adhesions. Alternative sites for initial access are indicated in [9].

Port placement: number and size

Generally, three trocars were used for small-to-moderate size hernias. However, if required, additional trocars were placed. Ports were placed in the form of an arc around the hernial defect (triangulation of trocars). At least one 10/12 mm trocar was placed for insertion of the mesh.

Adhesiolysis and reduction of sac contents

Once the appropriate number of trocars was introduced into the abdomen and adhesiolysis had commenced, the entire scar and surrounding areas were explored to exclude multiple defects (Swiss cheese defects) and occult hernias. Adhesiolysis was performed for at least 5 cm around the hernial defects and the previous scar using cold scissors. Electrocautery or any other energy sources were not used during adhesiolysis to preclude the possibility of bowel injury. In most patients there existed an avascular plane between the abdominal wall and viscera, which was accessed and developed for adhesiolysis. For dense bowel adhesions the parietal peritoneum was incised around the adhesions to avoid accidental enterotomy. For the reduction of bowel, atraumatic bowel graspers were used.

Mesh sizing and placement

After adequate delineation of all the defects and the scar tissue, the size of the mesh required was assessed. Assessment of the hernial defect was done by direct measurement of the largest diameter of the hernial defect as measured intra-abdominally during laparoscopy. To the measured size of the defect 5 cm were added in all directions to provide for overlap in all directions (Fig. 1). The mesh configuration and sites for four, transfascial sutures were marked on the abdominal wall. A percutaneous centering suture was passed intra abdominally, through the midpoint of the hernial defect and was retrieved through the 10/12 mm port, which was to be used for the insertion of the mesh (Fig. 2). The suture was then tied to the centre of the mesh. The mesh was rolled and inserted through the same 10/12 mm port. All necessary precautions were taken to avoid contamination of the mesh with skin pathogens by avoiding contact of the mesh with the abdominal wall of the patient. The existing port was replaced by a larger (18 mm) port in some patients for insertion of a larger mesh.

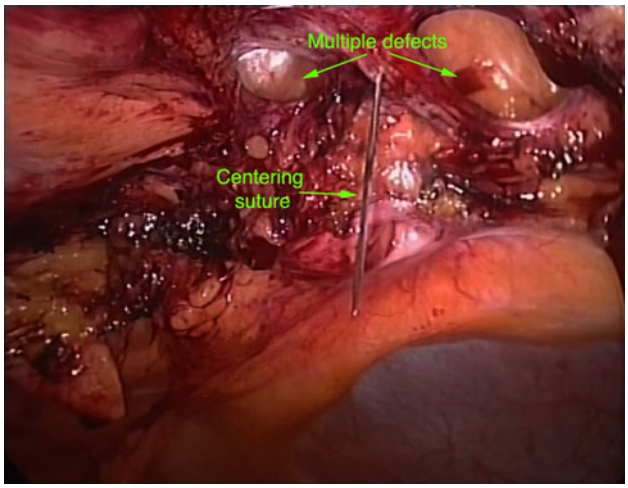


Fig. 1 Mesh overlap

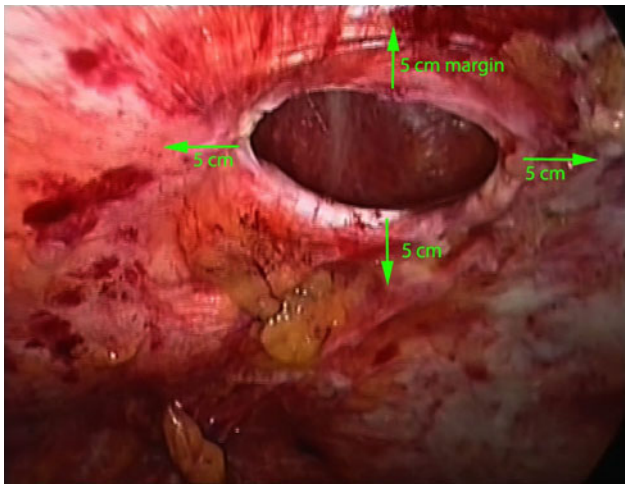


Fig. 2 Multiple hernial defects with centering suture in situ

Fixation of mesh

Transfascial sutures were used in patients ($n = 544$) in whom a non transparent mesh was used (Dual, ePTFE, Parietex, Bard Composix, Proceed) to facilitate correct and optimal positioning of the mesh relative to the hernia defect prior to fixation. Transfascial sutures were taken at the previously marked sites through a stab incision with the help of a fascia closure needle. The mesh was additionally fixed with the help of a fixation device (ProTack®, Autosuture/US Surgical, Norwalk, CT; Hernia stapler; EndoAnchor®, Ethicon Endo-Surgery, Cincinnati, OH). In the initial period, Hernia Stapler® was used as the fixation device. However, with subsequent availability of Protack®, this was the preferred fixation device due to perceived additional tensile strength of fixation and delivery through a 5 mm port. The metallic fixations were applied at 3 cm intervals. A 'double crown' technique was used in which two circumferential rows of metal fixations were applied. The inner row of metallic fixations was applied around the periphery of the defect and an outer row at the periphery of the mesh. The two rows of fixation were staggered to preclude the possibility of the bowel herniating between mesh and abdominal wall.

Finally, the available omentum was laid over the underlying bowel loops in an attempt to prevent contact of underlying bowel with the mesh. Ports 10 mm and larger were closed under vision using a fascia closure needle.

A local occlusive pressure dressing was applied at the site of hernia postoperatively.

Hernias in unusual locations

Suprapubic and lumbar hernias

In these patients, we created distal peritoneal flaps by incising peritoneum to expose rigid, defined anatomical structures (e.g. pubic bone, Cooper's ligament) to which distal margin of the mesh is fixated (Fig. 3).

Subcostal and epigastric hernias

These hernias necessitate placement of an intraperitoneal mesh and fixation to costal margins of underlying ribs.

Post operative

Post operatively, the patients were encouraged to ambulate as soon as they had recovered from the effects of anaesthesia. The patients received intramuscular Diclofenac 75 mg 8-hourly in hospital unless declined by them. Patients were discharged from hospital once they were comfortable on oral analgesics (non-steroidal anti-inflammatory drugs), which were continued for 5 days post operatively.

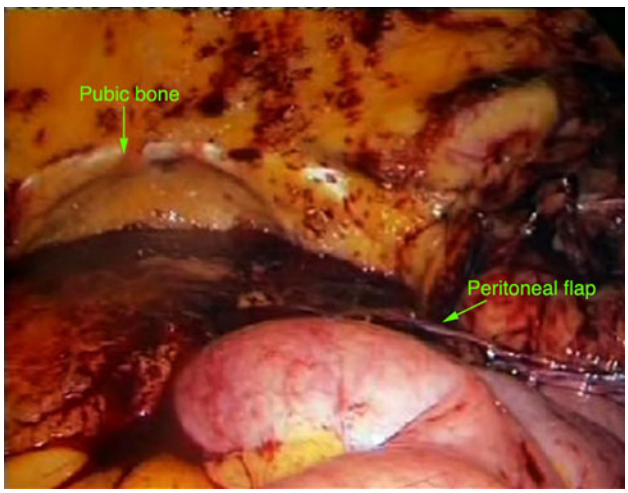


Fig. 3 Peritoneal flap technique for repair of suprapubic hernia

Follow up

The patients were followed up first on the 7th post-operative day for removal of post operative pressure dressings and stitches. They were subsequently followed up once at 3 months post operatively, and yearly thereafter on an outpatient basis. During follow-up visits, a clinical examination was performed to exclude recurrence of hernia. In case of doubt, an USG/CT examination was performed to diagnose recurrence. Follow-up data of patients who failed to report for their annual outpatient appointments was sought, in the first instance, from the doctors who had referred those patients for surgery. In the absence of relevant information, a structured interview was held by telephone to assess post-operative follow-up status. The patients were asked specifically about post-operative residual lumps/swellings, any recurrent bulges/lumps, chronic/recurrent pain and any other post-operative symptoms. A fresh outpatient appointment was offered to all patients. In spite of the above measures, 22% patients were lost to follow-up.

Data analysis

Data collection was manual and retrospective up to 1998. Since then, data has been collected prospectively on an indigenously developed software and analysed on Microsoft Excel® using SPSS package®.

Results

Over a period of 13 years and 3 months (January 1992–June 2005), 1,242 patients had LVIHR at our department. These included all patients who presented with ventral, incisional and recurrent hernias and were eligible for surgery except patients with redundant abdominal walls and marked loss of abdominal domain. Thirty four patients who had a totally extraperitoneal mesh repair and were previously reported have also been excluded.

The most common presentation was a slow-growing painless lump in the abdominal wall (78%). A history of localised pain along with abdominal swelling was present in 17% of patients. A history of transient subacute intestinal obstruction was elicited in 12% of these patients. In 5% of patients, detection of the ventral hernia was incidental during a routine health check up (Table 1)

The mean follow-up in our study was 5.4 years (range 2.4–10 years) and overall patient follow-up rate was 78%.

Nineteen patients required conversion to open surgery (Fig. 4). Six patients were converted to a formal laparotomy in our initial experience. Since then, we follow a technique of limited conversion with a small target skin incision over the hernial sac and subsequent laparoscopic intraperitoneal placement of mesh.

Table 1 Patient demographics, hernia defects and surgical procedure

Patient factors	
Male/female	458/784
Age in years	46 (14–85)[a]
Body mass index	32 (22–52)[a]
Factors related to hernial defect	
Defect diameter (largest diameter in cm)[b]	4.70 (1–20)[a]
Defect size (cm^2)	26.2 (0.79–314.3)
Multiple defects	579
Occult hernias[c]	203
Suprapubic hernias	126
Incarcerated hernias[d]	212
Recurrent hernias	252
Lumbar hernias[e]	96
Factors related to the procedure performed	
Mesh to defect ratio	37.5 (1.9–183.3)
Operating time (minutes)	81 (20–180)
Estimated blood loss (ml)	51 (20–300)
Postoperative hospital stay (days)	1.9 (1–4)
Conversion to open repair	19 patients
Complete conversion	6 patients
Limited conversion	13 patients

[a] Mean (range)

[b] Defect diameter denotes intra-operative direct measurement of maximal diameter of hernial defect as measured intraperitoneally during laparoscopically

[c] Occult hernias include all patients who had a hernial defect more than 3 cm away from the clinically apparent defect

[d] Incarcerated hernias include all irreducible hernias

[e] Lumbar hernias include primary and incisional hernias

There were two bowel injuries during initial access (stomach and small bowel). Both were managed with bowel sutures placed laparoscopically. Bladder injury during initial access occurred in a female patient with multiple previous lower abdominal surgeries. It was managed with suture and bladder decompression for 10 days with indwelling urinary catheter. Other visceral injuries included four liver injuries and one splenic injury, all were managed conservatively (Table 2).

Two patients presented with small bowel obstruction in the immediate postoperative period. One of these patients required laparotomy for an incarcerated knuckle of small bowel at port site. Four other patients presented with subacute small bowel obstruction at variable times after surgery ranging from 2 to 7 years post operatively. None of these patients required surgery for the small bowel obstruction.

Iatrogenic enterotomy during adhesiolysis occurred in 27 of 1,242 (2.17%) patients, 25 during adhesiolysis and 2 during initial access. Six patients required conversion to an

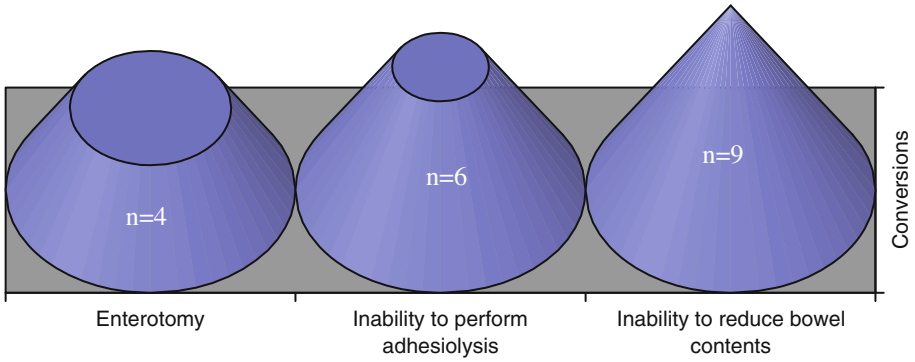


Fig. 4 Patients requiring conversion to open surgery

Table 2 Complications

Complications	Patients (%) (n = 1,242)
Intra operative	
Intestinal injury during initial access	2 (0.16)
Bladder injury during initial access	1 (0.08)
Intestinal injury during adhesiolysis	19 (1.5)
Bladder injury during adhesiolysis	1 (0.08)
Inferior epigastric artery injury	87 (7.0)
Other visceral injury	5 (0.4)
Conversion due to intestinal injury	6 (0.5)
Early post operative	
Prolonged ileus	22 (1.77)
Port site bleed	8 (0.64)
Haematoma or postoperative bleeding	4 (0.33)
Cardiac event	27 (2.1)
Urinary retention/UTI	46 (3.7)
Renal failure	1 (0.08)
Respiratory distress/pneumonia	12 (0.9)
Deep vein thrombosis	10 (0.8)
Wound infection	8 (0.64)
Mesh infection	2 (0.16)
Fistula formation	4 (0.32)
Late post operative	
Recurrence	55 (4.4)
Seroma (<3 months)	311 (25)
Chronic pain (>6 months)	182 (14.7)
Small bowel obstruction	6 (0.48)
Trocar site hernia	8 (0.64)

open procedure for a tissue repair. Nineteen patients had repair of the enterotomy laparoscopically, following which 11 patients had an intraperitoneal mesh during the same procedure while repair was deferred to a later date (4 weeks) in 8 patients. In two patients, enterotomy and peritoneal spillage was detected in the post-operative period. The first patient presented on the 5th post-operative day with features of peritonitis, for which a laparotomy was performed and the mesh removed. A tissue repair was performed at the same time—the patient developed a recurrence 3 months later. The other patient had a localised low output small bowel fistula, which was treated conservatively and the mesh removed after 3 months. This patient also developed a recurrence after 6 months.

Occult hernias are clinically undetected hernias. We have categorised occult hernias as those within 3 cm of the clinically detected defect, those more than 3 cm from the clinically detected defect but in the same scar, and a separate (distinct) hernia unrelated to the scar or the clinically detected hernia. The importance of classifying the defects into these three categories lies in the fact that defects more than 3 cm away from the clinically detected defect are the ones most likely to be missed during an open repair, leading to recurrence.

Intestinal fistula occurred post-operatively in four patients, all in the early post-operative period (<3 months). Three patients required removal of infected meshes. Two patients had laparotomy and small bowel suture. In one patient, the fistula healed spontaneously, and in another patient, the fistula healed after removal of an infected mesh. In all patients, the cause of fistula was iatrogenic small bowel injury, unrecognized at the time of hernia repair.

For the purposes of definition in this series, seroma was stated to be present whenever there was a clinically apparent swelling/lump at the site of previous hernia during the post-operative period. Seroma formation was seen in 30.9% (170/551 patients) of patients in the initial period of the study. The rate of seroma formation decreased to 20.4% (141/691patients) after the routine application of occlusive pressure dressings for a week post-operatively. The association between decrease in seroma formation and pressure dressing was significant ($P < 0.000$). Only 65 (5.2%) patients had large seromas on clinical examination, which persisted for more then 3 months. In our experience, only three patients required multiple aspirations for seromas causing pressure symptoms or excessive discomfort. Two patients required excision of localised fibrotic cavities containing haemorrhagic fluid at 4 and 6 months postoperatively. There was no segment of exposed mesh post-operatively and these patients recovered uneventfully.

Table 3 Correlation of method of fixation with chronic pain

Method of fixation	Patients with chronic pain (%)
ProTack® alone	61/479 (12.7%)
EndoAnchor® alone	1/10 (10%)
EMS Stapler® alone	31/209 (14.8%)
Transabdominal sutures + ProTack®	89/544 (16.4%)*

* $P = 0.078$—univariate analysis to find association of chronic pain with transabdominal sutures plus Protack as compared to all other fixation methods put together using Chi square test

In our experience, wound and mesh infection rates were 8/1,242 (0.64%) and 2/1,242 (0.16%), respectively.

The highest incidence of chronic pain was seen in patients in whom transabdominal sutures and tacks were used together; however, the association was not significant ($P = 0.078$) (Table 3).

Trocar site hernias were observed in eight patients. All trocar site hernias occurred in the midline. In six patients, herniation occurred through a 10 mm port site that was not closed post-operatively and in 2 patients trocar site hernia occurred through a 5 mm port site.

Recurrence of hernia was observed in 55 patients (4.4%) at a mean of 11.6 months (range being 6–18 months) after surgery. Late recurrences are reported and CT scans may be helpful in detecting occult late recurrences. Recurrence rate was 21/209 (10%) with EMS staplers® (Ethicon Endo-Surgery, Cincinatti, OH) as compared to 34/1,033 (3.3%) for all the other fixation techniques. There was significant correlation between use of staplers and recurrence ($P < 0.000$). Recurrence rate when Prolene® mesh (Ethicon, Somerville, NJ) was used with Protack® was 3.5%, while the overall recurrence rate of the study was 4.4% (Table 4).

We had the opportunity to operate on 23 patients who had a recurrence after a LVIHR at our centre. The most common cause of early recurrence was displacement of the mesh as a result of failure of fixation device (Staples) in 6 patients (25%). In 14 patients (60%), mesh overlap was deemed to be less than 3 cm on subsequent review of the recorded operative procedure, and in 3 patients (13%), mesh contraction and invagination into the hernial defect (late recurrence) was the recorded cause of recurrence. One patient had mesh failure wherein the mesh expanded to take the shape of the hernial sac, thus forming a pseudo hernial sac. All patients with recurrent hernias were offered LVIHR. Adhesiolysis was possible in all patients except one in whom the procedure was converted to an open repair. Another intraperitoneal mesh was used with 5 cm overlap from the hernial defect and secured with transfascial sutures and tacks.

The mean follow up in our study was 5.4 years (range 2.4–10 years) and patient follow up rate was 78%. The patients were followed up first on the 7th post-operative day for removal of post-operative pressure dressings and stitches. They were subsequently followed up once at 3 months post operatively, and yearly thereafter. The follow-up data of patients who failed to report for their annual appointments was sought, in the first instance, from the doctors who had referred those patients for surgery. In the

Table 4 Hernia recurrence and patient characteristics

Characteristic	Patients with recurrence	Patients without recurrence	*P* value
General characteristics [median (range)]			
Patient age (years)	53 (18–77)	52.3 (18–77)	0.666[a]
BMI (kg/m^2)	34.5 (25–48)	31.7 (22–52)	0.001[a]
Size of hernia (area)	47.2 (0.8–314.3 cm^2)	44.8 (0.8–314.3 cm^2)	0.677[a]
Period of recurrence (months)	4.6 (6–18)	–	–
Recurrent hernias	13/252 (5.2%)	239/252	0.528[b]
Non recurrent hernias	42/990 (4.2%)	948/990	–
No. of hernial defects			
Single defect	26/662 (3.9%)	636/662	0.180[b]
Multiple defects	29/570 (5.0%)	551/570	–
Hernia recurrences and mesh to hernia ratio [mean (SD)]			
Single hernial defect	35.8 (47.6)	42.1 (47.18)	0.497[a]
Multiple hernial defects	31.9 (26.8)	32 (26.4)	0.975[a]
Hernia recurrences and fixation techniques			
EMS stapler®	21/209 (10%)	188/209	–
ProTack®	19/479 (3.9%)	460/479	–
EndoAnchor®	1/10 (10%)	9/10	–
Transabdominal sutures and ProTack®	14/544 (2.6%)	530/544	–

[a] Student *t* test was applied for univariate analysis of these factors to find association with recurrence

[b] Chi-square test was applied for univariate analysis of these factors to find association with recurrence

absence of relevant information, a structured telephone interview was held to assess post-operative follow-up status. In spite of the above measures, 22% patients were lost to follow-up.

Discussion

The present report takes the form of an observational review of accumulated experiences with LVIHR in an attempt to address several unresolved issues with the technique. Data collection was partially retrospective. This is not a randomised study with set goals and end points and as such there are several inherent limitations. The statistical analyses in the study are all univariate. Caution needs to be exercised in the interpretation of these findings as multiple factors are associated with each variable and a multivariate analysis is desirable in these circumstances. The data in our study may be inadequate for such an analysis and thus it was not possible to perform a multivariate analysis. However, our endeavour was to provide evidence using univariate analysis in favour of findings that we have found significant in our own clinical experience.

The advantage of laparoscopy and adhesiolysis is that occult hernias can be detected and treated optimally using a larger mesh that covers all hernial defects with an adequate margin. Of the 1,242 patients in our study, 580 (46.6%) patients had more than one defect and 203 (16.3%) of these patients had the defect detected laparoscopically more than 3 cm away from the clinically apparent defect. Twenty-five (2%) patients had a coexisting primary hernia along with the clinically detected hernia. Saber et al. [10] reported that out of 146 laparoscopic ventral hernia repairs, 70 patients (48%) were found to have occult defects that were not detected upon pre-operative abdominal examination. We believe that laparoscopically detected occult hernias are one of the factors responsible for the lower incidence of recurrence following laparoscopic repair.

Inadvertent enterotomy remains one of the most important complications during LVIHR. The prognosis worsens significantly if the enterotomy is not recognised intra operatively. The incidence of inadvertent enterotomies was low in our experience. We attribute this to our policy of avoidance of the use of an electrocautery/energy source for adhesiolysis. Cold scissors was our instrument of choice for adhesiolysis, especially in proximity to the bowel. We follow a policy of immediate bowel suture following a suspected enterotomy. The advantage of suturing a suspicious enterotomy immediately is two fold: spillage of intestinal contents is avoided, and secure closure of the enterotomy attained. More importantly, recognition of the site of the enterotomy is not a problem at this stage as soon as the injury has occurred. Localisation of the site of injury at a later stage in the operation may be extremely difficult as the enterotomy may be covered by a blood clot or tissue debris.

In the initial part of our experience, patients requiring conversion were subjected to a formal laparotomy and subsequent repair of the hernia with or without placement of prosthesis. We have subsequently devised a procedure (limited conversion) [11] that retains many of the benefits of a laparoscopic approach (small target incision, placement of large prosthesis by intraperitoneal approach, early rehabilitation and early discharge from hospital) while providing the advantages of an open approach under difficult conditions to lyse adhesions or suture bowel that may be densely adherent to the hernial sac. The term ‘limited conversion’ was devised for a procedure wherein bowel reduction/adhesiolysis/enterotomy repair was performed through a small targeted skin incision over the hernial sac. After skin closure, this was followed by laparoscopic placement of intraperitoneal mesh.

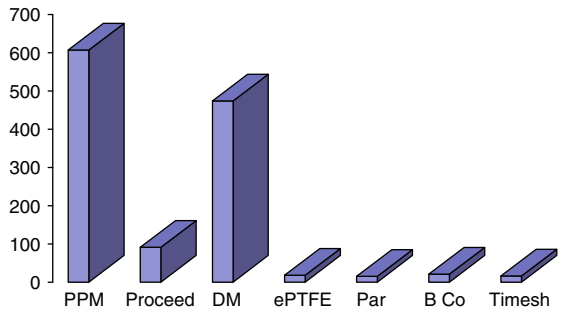
LVIHR is associated with low rates of wound and mesh infection [12]. The reasons for a low mesh infection rate are two fold. With the laparoscopic approach, the mesh is inserted by a “no touch” technique with no contact of the mesh with the abdominal wall of the patient. Secondly, the ports of surgical access are remote from the site of placement of mesh intra-abdominally.

Measurement of the size of the hernial defect needs to be standardised to ensure accuracy of data. In a review of articles on the subject, the actual modality of measurement of hernia size is not mentioned [1, 4, 6]. Measurement of hernia size during physical examination is likely to be approximate and therefore inaccurate. We propose that the size of the hernia be reported as the largest diameter of the hernial defect when measured directly intraperitoneally during laparoscopy. For multiple hernias, the diameter may be calculated as the maximal distance between two defects farthest apart in the same scar. We feel it is important to devise a system to report the size of the hernial defect in the presence of multiple defects. The measurement system proposed above has been devised since we feel it is important when corroborated with measurement of mesh size to analyse outcomes.

Mesh to hernia size ratio in our study was high as compared to other large series [5]. The reason for this was that hernia size was measured intra-abdominally during laparoscopy rather than externally. This is reflected in smaller hernia sizes. The other reason was the strict criteria of a 5 cm overlap of the mesh beyond the hernial defect. The mesh to hernia ratio is, theoretically, a good criterion for assessing the size of the mesh to be applied for a particular defect. However, it is fallible in patients with multiple defects and weak scars. It is not always possible to calculate the area of multiple defects accurately especially when they are far apart. Thus, although the size of the hernias in a scar might

be small, the size of the mesh required for adequate coverage of the defects and the entire scar will be large. We found that the mesh to hernia ratio was lower in patients who developed a recurrence as compared to those who did not develop a recurrence (Table 4). The difference was more prominent in patients with single hernial defect as compared to patients with multiple hernial defects; however, these differences were not statistically significant.

In the initial years of our experience, a polypropylene mesh (PPM) was the mesh of choice for LVIHR. This was necessitated by financial constraints and also because of familiarity with PPM. There have been concerns about use of PPM in an intraperitoneal location [13, 14], especially regarding small bowel occlusions and fistulisation. On the contrary, several surgeons have reported use of PPM in an intraperitoneal location with no bowel obstructions or fistulisation [12]. This corroborates our own experience, wherein we found PPM to be safe in the context of clean, planned surgery using available omentum as a barrier between bowel and mesh. In our series, all four patients who developed post-operative small bowel fistulae in the early post-operative period were related to iatrogenic small bowel injury at time of surgery and not due to corrosion of small bowel with mesh. However, newer meshes like DualMesh® (Gore, Flagstaff, AZ) and Proceed® (Ethicon, Somerville, NJ) have been used with increasing frequency in recent years (Fig. 5). A large variety of meshes are available at present for LVIHR. However, the search for the "ideal" mesh continues and we have used several such meshes. A comparison of the relative safety and efficacy of different meshes was not attempted in the context of this publication.



PPM	Proceed	DM	ePTFE	Par	B.Co	Timesh
607	91	474	18	15	21	16

PPM – polypropylene, **DM** – DualMesh®, **ePTFE** – expanded PTFE patch,

Par – Parietex® (Sofradim, Villefranche-sur-saone, France),

B Co – Bard Composix® (CR Bard, Cranston, NJ, USA),

Timesh (GfE MEDIZINTECHNIK GmbH (Nurnberg, Germany).

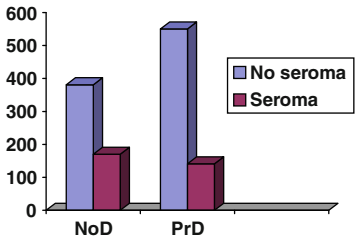
Fig. 5 Types of biomaterials used for laparoscopic ventral/incisional hernia repair (LVIHR)

We have found the centre suture and transfascial sutures combined with marking of the mesh on the abdominal wall an efficient method for attaining optimal positioning of the mesh. Marking of the mesh over the abdominal wall helps in correct orientation of the mesh with reference to the defect, thus ensuring a 5 cm overlap on all margins. The centre suture helps in orientation of the centre of the mesh to the centre of the defect. The transfascial sutures help to hitch mesh to the abdominal wall, thus facilitating handling of the mesh during application of metal fixations. Our choice of metal fixation device is ProTack®. We have used it in over 800 patients and find the 5 mm single use instrument to be easy to handle and effective in secure fixation of the mesh. The recurrence rates at our centre have been low (3.5%) when Prolene® mesh has been used with ProTack® fixation. The recurrences rates at our centre were high (10%) when EMS stapler® was used as the sole fixation for the mesh (Table 4). It has been shown in experimental studies that the stress-bearing capacity of a mesh fixed with helical fasteners is four times that of a mesh fixed with staplers [15, 16]. In our experience, the EndoAnchor® had the disadvantage of bleeding from the point of entry of the needle and there were also concerns about injury to the surgeon's fingers with the needle while applying counter pressure during application—particularly in thin patients.

Our current protocol is to use four transfascial sutures at the four corners of the mesh to provide transfascial (full thickness) fixation in patients in whom a non-transparent mesh is used. In our experience, the main advantage of the transfascial fixation sutures is to aid in optimal positioning of the mesh intra operatively. We use polyglactic acid sutures to avoid the possibility of sinus/granuloma formation at the suture site. We do not feel that transfascial fixation sutures are mandatory with PPM. PPM are transparent (see-through) meshes, which aids in optimal intraperitoneal placement of mesh relative to the hernial defect. Also, polypropylene-based meshes incorporate well with the abdominal wall due to the extensive reaction that they initiate with the surrounding tissues.

There was a high incidence of seromas in our study until January 2000. Thereafter we started using occlusive pressure dressings, which significantly decreased the rate of seroma formation (Fig. 6). These dressings were applied immediately after the surgery while the patient was still under anaesthesia, and were removed on the 7th post-operative day at first follow up. Tsimoyiannis EC et al. [16] reported a decrease in seroma occurrence following cauterisation of the hernial sac. We are in the midst of a study evaluating the use of fibrin sealant within the hernial sac for decreasing the incidence of seroma formation. In our experience, the vast majority of seromas resolved within 6 months of surgery.

We believe that chronic pain in patients with LVIHR is due to a combination of synthetic mesh abrading sensitive



	NoD	PrD
No Seroma	381	550
Seroma	170	141

NoD – No pressure dressing applied,
PrD – Occlusive pressure dressing applied.
Chi Square test used for statistical analysis (P < 0.000)

Fig. 6 Correlation between application of pressure dressing and seroma formation

parietal peritoneum and the use of penetrating fixation devices. The incidence of chronic pain in our series (Table 3) was 14.7% (182 patients). There was no significant correlation between any particular fixation technique and chronic pain. In most patients the pain was fairly well localised on the abdominal wall. Injection of local anaesthetic ameliorated symptoms in these patients.

Conclusion

LVIHR leads to low recurrence rates and low rates of wound and mesh infection. This approach can be used optimally for hernias in difficult locations and in obese patients. It offers several advantages of a minimal access approach; however, chronic pain remains an unresolved issue. We surmise that the reasons for the lower recurrence rates after LVIHR are the detection of occult hernias and use of a larger mesh with greater overlap.

Conflict of interest None.

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