Intraoperative Considerations for Laparoscopy

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Introduction

The laparoscopic approach for ventral hernia repair began over 20 years ago with the first published report in 1993 by Karl LeBlanc in Baton Rouge, Louisiana [1]. Despite its equivalent cost and hospital resource utilization [2], and patient benefits over open repair [3], the laparoscopic technique is still utilized in only about 20% of all ventral hernia repairs [4, 5]. Given the benefits to patients, logic would dictate that the relative lack of utilization is mostly due to technical difficulty and gaps in laparoscopic skill acquisition necessary for the adhesiolysis, mesh placement, and mesh fixation. There has been recent interest in utilizing a robotic-assisted surgical device (RASD) for laparoscopic ventral hernia repair (LVHR), the details of which will be covered elsewhere in this book. These relatively new tools for LVHR may allow increased adoption of the laparoscopic approach, but it is important to note that the fundamentals of the laparoscopic approach should not be changed without scrutiny and informed consent. These fundamental principles include known risk factors for recurrence, such as utilizing an adequate size mesh with appropriate strength and fixation, all of which become increasingly important as the size of the hernia defect and number of previous failed repairs increases.

Another important and fundamental aspect of LVHR is utilizing the most appropriate technique, a decision that can sometimes be difficult to make. Use of an algorithm, such as that listed below, can be helpful in deciding whether or not to utilize a laparoscopic approach.

Algorithm for ventral hernia repair

1. Explicitly identify the patient's goals of repair (e.g., symptom relief, abdominal wall contour issues).
2. Align the patient goals with the health care team (keep goals realistic).
3. Consider the clinical scenario (emergent, urgent, elective).
4. Consider the patient's history (medical conditions, previous hernia repairs, postoperative complications, types of typical activities, etc.)
5. Consider the details of the hernia (defect and sac size, location, overlying skin changes).
6. Choose a repair technique that will most likely meet the above goals (open, laparoscopic, hybrid, myofascial flap of the trunk, etc.)
7. Choose a prosthetic most appropriate for the technique (intra/extraperitoneal design, proper strength if bridging, etc.)

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Access

For laparoscopic surgery in general, existing data do not support one method of trocar insertion over another [6]. Initial access for LVHR should generally be performed under direct visualization, although the existing data suggest a Veress needle can be safely placed away from old incisions with proper training and experience [7]. Direct visualization techniques include open techniques or use of an optical entry trocar. In general, the first port should be placed as far from previous scars and the hernia defect as possible [8].

The secondary ports used for the working instruments and scope should also be placed as far from the hernia as possible, in order to allow for adequate working space, visualization of the defect, and repair of the defect. Once the primary port has been placed, secondary ports should be placed under direct vision to avoid unrecognized visceral injury.

Occasionally, adhesions are covering the area of the desired location of the secondary ports, requiring that some adhesiolysis before placing them. One strategy for this is to utilize a 10–12 mm port as the first port, and operate through this port to take down enough adhesions to allow a secondary port to be placed. This can be accomplished by using the scope itself to brush the adhesions down, or using a 5 mm instrument adjacent to a 5 mm scope, both placed through the same port. Standard ports with mechanical seals to maintain pneumoperitoneum can be used, but the technique is enhanced with use of the AirSeal™ port (ConMed, Utica, NY), which does not use a mechanical seal, and will maintain pneumoperitoneum and thus operative exposure when utilizing two separate instruments through a single port.

Another access strategy utilizes an open technique for the initial port placement that is somewhat closer to the hernia or previous scars. In addition to initial access, this port can then be used for subsequent mesh insertion. Its location relatively close to the defect will ultimately be covered with the mesh, eliminating the need for fascial closure, provided the port site is not too close to the edge of the mesh. This strategy could also be accomplished by performing the adhesiolysis first, utilizing all 5 mm ports, then placing a secondary 10–12 mm port within the boundaries of where the mesh will be placed, or through the hernia defect itself. If the skin overlying the hernia sac will be used for port and/or mesh placement, consider closing the skin well in order to prevent leakage of seroma fluid, as seromas within the hernia sac are common after LVHR [9].

Three ports on one side of the abdominal wall are most commonly utilized. For midline hernias, I usually place the first port in the left upper quadrant, and the two working ports evenly spaced inferior to this. With increasing area covered by adhesions, and larger defects/mesh, it is more common and necessary to also place ports on the opposite side of the abdomen. Usually two additional ports are necessary, however, if the defect and/or mesh is large enough, a third port will be placed on the opposite side as well (Fig. 7.1). These additional ports are frequently used for not only dissection, but mesh fixation as well. In my

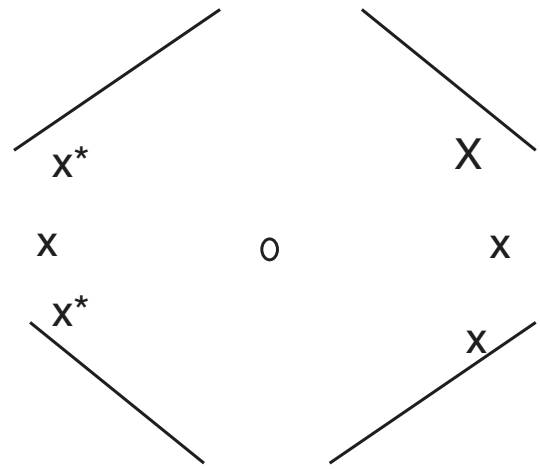

Fig. 7.1 Typical port placement for laparoscopic ventral hernia repair. The ports on the patient's left side are often the only ports necessary. Additional 1–3 ports placed on the patient's right side are necessary for larger defects and larger mesh sizes. *X* = 10–12 mm, *x* = 5 mm, * = For cases requiring right sided ports, 1–3 ports are utilized depending on the tasks required. Most commonly, two extra ports are used

practice, I still see patients with recently repaired recurrent hernias, where the mesh was displaced towards the side of the abdomen opposite from the port sites, thereby leaving the defect edge in close proximity to the mesh edge on the ipsilateral side. Simply placing ports on the opposite side of the abdomen would be anticipated to allow for use of a larger mesh, more accurate placement, and better fixation, thus reducing the risk of hernia recurrence.

Lysis of Adhesions

This portion of the operation can be one of the more challenging aspects to a laparoscopic approach for ventral hernia repair. In general, there are two types of adhesions I consider—acquired and anatomic. Acquired adhesions develop after previous surgical procedures, trauma, or some type of intra-abdominal inflammatory process. Anatomic adhesions are naturally occurring peritoneal ligaments, such as the umbilical and falciform ligaments.

It is important that a wide area surrounding the hernia is freed from adhesions in order to assess the presence of additional, unsuspected hernia defects, and have a wide enough area to place an appropriately sized mesh adjacent to the abdominal wall. Indeed, this usually mandates lysing all of the adhesions from the anterior abdominal wall, particularly for midline hernias. Even primary midline hernia defects are adjacent to the umbilical and falciform ligaments, which in my opinion should be taken down prior to mesh placement. When taking these ligaments down, I begin near the umbilicus, and proceed caudad and cephalad, leaving the ligaments attached where they are thickest, typically over the bladder inferiorly, and at the ligamentum teres superiorly. Inferiorly, this dissection is often carried out all the way to the symphysis pubis, exposing Cooper's ligaments bilaterally. Superiorly, the dissection is carried out to, or above the xiphoid process, depending on the proximity of the hernia defect to the xiphoid. The extraperitoneal fat is mobilized as closely as possible to the lateral attachments to minimize the amount of fat between the mesh and the abdominal wall. In contrast to acquired adhesions, where an energy source is used carefully, and sparingly, there is less risk of inadvertent thermal injury when taking down the umbilical and falciform ligaments, and thus a more liberal use of an energy source is typically utilized. The exception to this is near the urinary bladder. It is often helpful to place a three-way bladder catheter preoperatively, and use this to instill sterile water or saline into the bladder, thus making the borders easy to visualize, and help avoid inadvertent injury.

Acquired adhesions are taken down with both blunt and sharp dissection, with sparing use of an energy source for hemostasis. Good visualization is critical, and for the more dense adhesions, precise fine motor control of the instrument tips is mandatory. It is important to recognize that as the further the laparoscopic instrument is placed into the port, the fulcrum on the instrument shaft moves towards the handle, resulting in more difficult fine motor control of the instrument tip [10].

The solutions to this are to employ a longer instrument, use two hands on the instrument to steady the tip, and/or place another port closer to the target. For example, while using non-energized scissors to lyse adhesions that are becoming increasingly far away from the ports, there will occasionally be a need to grasp the tissue adherent to the abdominal wall at a safe location, lock the grasper, and have an assistant apply gentle traction. Two hands are then placed on a longer scissor to improve fine motor control of the scissor tip, and the adhesiolysis can be completed in this area. It is also important to note that adhesions that are very close to the port site can also cause problems with fine motor control, particularly because they are often done at an odd angle to the viewing scope, sometimes even with a mirror image view.

The use of an energy source during adhesiolysis is quite acceptable, but fundamental knowledge of the energy type being used will help mitigate the risk associated with its use [11]. For example, an ultrasonic energy device is commonly used for this purpose, but the heat

Table 7.1 Adhesiolysis—factors that increase risk and difficulty level, and helpful tips for management of these scenarios

	Clinical scenario	Mitigation strategies
Increased density	Discovered intraoperatively	Improve fine motor control by using two hands, adjusting port sites, utilizing assistant for retraction
		Avoid energy source near critical structures
		Use sharp scissors
Difficult location		
Close to initial port site insertion	Discovered intraoperatively	Use a sweeping motion of the scope to take down flimsy adhesions under direct vision
		Use scope and scissors and/or grasper through the same port to get started. AirSeal™ port particularly useful in this scenario
Anterior portion of anterior abdominal wall	Suggested preoperatively: Irreducible hernia contents, Small defect, large hernia sac Discovered intraoperatively: Parastomal hernia (especially bowel leading to stoma)	Adjust ports (number and/or location) as necessary to improve retraction. Use of extra ports and an assistant to retract may also be helpful
		Avoid energy source near bowel
		Utilize an open incision at or near the area of dense adhesions, avoiding or resecting areas of poor skin quality
		Open defect laparoscopically to allow better access to adhesions
Adjacent to critical structures (GI tract, urinary bladder, diaphragm, iliac vessels)	Discovered intraoperatively, previous prostatectomy or lower midline incision (concern for urinary bladder adhesions)	Improve fine motor control by using two hands, adjusting port sites, utilizing assistant for retraction
		Avoid energy source if near a critical structure
		Use sharp scissors
		If urinary bladder is a concern, place a 3-way catheter preoperatively, and use this to instill sterile water or saline to fill up the bladder to identify the borders, which are typically covered in fat

associated with its use should not be underestimated. A short period of cooling after use, but before handling sensitive tissue, such as the GI tract, will help avoid thermal injury to the bowel. If there were a concern regarding a thermal injury to the bowel, one should strongly consider some sort of imbricating sutures over the suspected area of injury.

Adhesions that are flimsy and do not involve bowel are less risky compared to adhesions that are dense and involve bowel. Therefore, the surgeon should adjust their ergonomics, use of energy, and visualization of the operative field according to the relative risk and difficulty of the adhesions.

One scenario where adhesions are notoriously difficult is when they are between the anterior aspect of the abdominal wall and the viscera (within the hernia sac), especially with a relatively small defect. Laparoscopic access to these adhesions is limited due to the intraperitoneal approach, a situation frequently encountered with large hernia sacs and parastomal hernias. These technically challenging situations sometime necessitate the placement of ports on the opposite side of the abdomen, or a hybrid open approach, with an incision placed near the area of difficulty. Again, use of an energy source in close proximity to critical structures, such as the GI or GU tract should be used with an abundance of caution. Table 7.1 lists the clinical scenarios and mitigation strategies for difficult adhesiolysis.

Measuring the Defect

Noting the size and location of the defect, as well as its shape, will help determine the most appropriate size and shape of the mesh, and whether or not the defect is amenable to closure. There are

many techniques available for this, with no data showing superiority of one method over another. An important principle however is to recognize that measurements taken on the outside of the abdomen, on the skin, will be larger than those taken from the inside of the abdominal cavity. This discrepancy is usually 1–2 cm, but increases with obesity, larger hernia sacs, and when the peritoneal cavity is fully insufflated. When measuring the defect from the inside of the abdominal cavity, it is important to measure the widest location of the defect in the vertical and transverse direction without skewing the axis. This can be accomplished by using spinal needles placed at the 12 and 6 o'clock, then 3 and 9 o'clock positions while measuring the defect dimensions from the inside with a suture, umbilical tape, or ruler.

Regardless of the method of defect measurement, the size and location of the defect should be documented in the operative note [7].

Closing the Defect

If one were to consider just the physics of covering a defect with a mesh, it is obvious that the pressure exerted on the mesh would increase as the mesh:defect ratio increases. As this ratio increases, the strength of the mesh and fixation become increasingly important. Therefore, closing the defect should decrease the pressure exerted on the mesh, and reduce the importance of the mesh and fixation strength. By way of examples, a 1 cm diameter defect at the umbilicus covered by a 20 × 30 cm mesh would render fixation strength almost irrelevant, whereas a 10 × 10 cm defect patched with a 10 × 10 cm mesh would be highly dependent on fixation strength in order to prevent recurrence. These extreme examples illustrate the changes in force experienced by the mesh based on the ratio of mesh:defect size.

Complicating intraoperative defect size however, with or without closure, is that it is not predictive of whether all or a portion of the defect closure will fail. Further, the variable contribution of tissue ingrowth in terms of fixation strength is also unpredictable. Therefore, it is probably best to minimize the contribution of defect closure and tissue ingrowth in terms of estimating the mesh:defect ratio, and size the mesh as though the defect was not closed, and tissue ingrowth was minimal. Clinically, defect closure has been seen to have variable influence on the outcomes of LVHR [12–14]. The ultimate application of this knowledge will be utilized by the surgeon, intraoperatively, keeping in mind the patient's goals and tolerance for risk in certain scenarios. This general concept of mesh:defect ratio as it relates to known risk factors for recurrence is illustrated in Fig. 7.2.

Choosing a Mesh

While a detailed explanation of mesh properties is not the goal of this chapter, I will highlight some important features that may help surgeons in their mesh choices. There are many properties of hernia prosthetics. Among these, strength is probably the most important. Surgeons and manufacturers frequently refer to weight as a surrogate for strength. While this this is a reasonable approach, lack of context and standard definitions present many pitfalls. The most common way to express the weight of a hernia mesh is in g/m^2. When comparing prosthetics, the weight/area metric is valid, as long as the mesh is composed of material with similar density. Many prosthetics however are made from different polymers, with different densities, and some contain absorbable components and permanent components. The permanent component is probably the most important in terms of hernia recurrence. Consider the recent manufacturer recall of PhysioMesh™ (Ethicon, Inc. Cincinnati, OH) [15], where the weight of the permanent polypropylene is only 28 g/m^2. This mesh was experiencing failures in strength, and was pulled from the market due to real world data from European her-

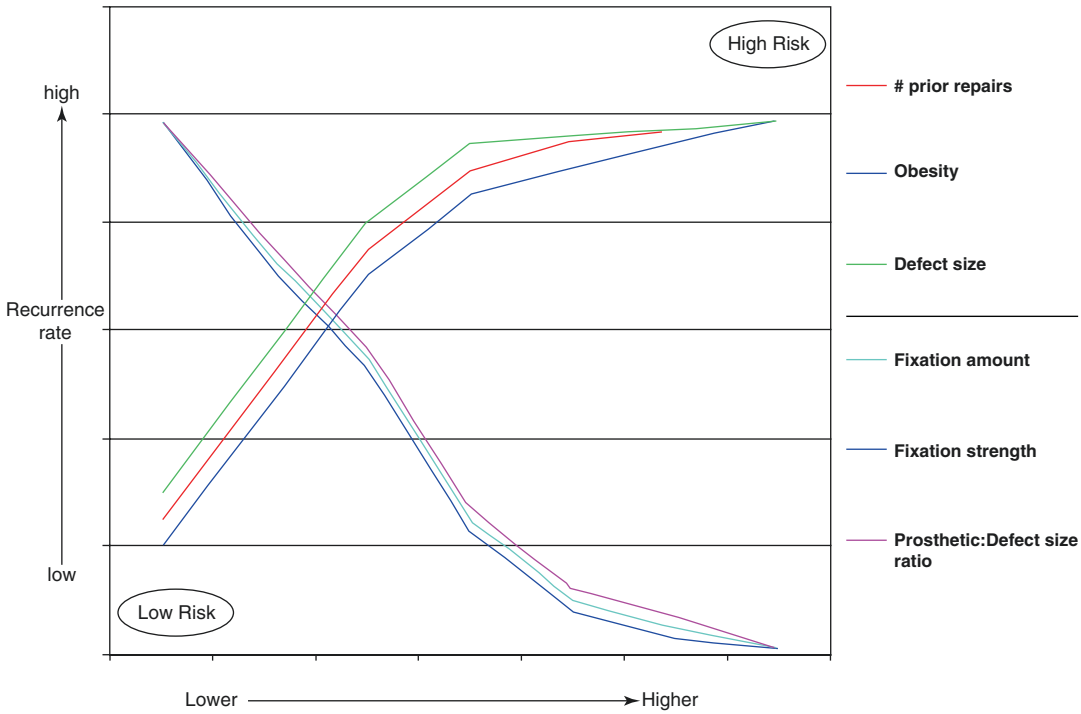

Fig. 7.2 Known risk factors for recurrence are plotted along the *X* axis, and anticipated risk of recurrence is plotted along the *Y* axis. As the risk factors (# of prior repairs, obesity, defect size) increase in total number present and individual values, recurrence rates are expected to increase. Recurrence rates are expected to decrease, with increasing fixation amount, strength, and mesh:defect ratio. In situations where risk factors are high (right upper quadrant of the graph), increasing fixation amount and strength, and mesh:defect ratio will become more important if recurrence is to be avoided. In low risk scenarios (left lower quadrant of graph), fixation and mesh size become less important. There are no absolute values, as it is the relative risk that is important to help guide the surgeon in mesh and fixation choices

nia registries. Compare this to the Marlex™ and Prolene™ mesh at around 95 g/m^2, and currently popular "lightweight" mesh, such as Bard's Soft Mesh™, Ethicon's Prolene Soft™, and Atrium's ProLite Ultra™, all at around 45–50 g/m^2, prosthetics known to perform well in a variety of situations where bridging may be required [16]. Because strength data is not universally available or obtained in a consistent manner, it is not easily comparable. However, bridging a defect with increasingly lower weight polypropylene mesh will be more likely to fail as the size of the defect increases. And because these may not be linear relationships, patient characteristics are variable and host tissue response is unpredictable, there is no cutoff point where one size/strength mesh should be used for a particular sized defect. So without a specific size and strength cutoff for the defect and mesh, respectively, it remains logical to *avoid scenarios where large defects are bridged with ultra-lightweight mesh*, particularly in obese patients [17].

Mesh Insertion and Placement

Inserting a large mesh through a small incision can be difficult. Usually, the larger and stiffer the mesh, the more difficult it is to place in the peritoneal cavity. Larger prosthetics typically require placement through the port site after the port has been removed. It is useful to pull the mesh in, rather than try to push it through the port and/or port site. To pull the mesh through, insert an appropriate locking grasper backwards through the 10–12 mm port, then remove the port which

will leave the instrument tip protruding from the port site. The mesh can then be grasped and pulled in. Reestablishment of the pneumoperitoneum is recommended before releasing the mesh and readjusting the grasper, so it can be done under direct vision. Smaller sizes of mesh can often be placed through the port itself. One must be careful and avoid the use of an excessive amount of force, as the subsequent release through the port could cause the instrument tip to enter uncontrolled into the peritoneal cavity, and unintentionally damage intra-abdominal organs.

Once the mesh has been inserted into the abdomen, it must be accurately placed on the anterior abdominal wall. Placement of a suture in the center of the mesh prior to insertion can be done, then the suture pulled through the skin in the center of the coverage area, and held in place while the mesh is fixed to the abdominal wall. Once fixation is accomplished, the suture can be removed [18].

Preplacement of sutures at the cardinal points (12, 3, 6, and 9 o'clock positions) is a frequently used technique. Some place the sutures at the corners of the mesh, but the corners are not typically at the location of the mesh closest to the defect, where stronger fixation is desired. These are then pulled out through corresponding stab incisions, then lifted to bring the mesh up to the abdominal wall, covering the defect. They can then be held or tied while additional fixation is placed as appropriate.

There are two devices currently available to assist with mesh placement. The AccuMesh™ device (Medtronic, Minneapolis, MN) can help with both insertion and placement, and utilizes a collapsible frame on which the mesh is fixed with releasable hooks. With the frame collapsed and the mesh rolled, it is inserted into the peritoneal cavity. The frame is then opened, which spreads out the mesh. The frame/mesh can be adjusted with the articulating shaft (four degrees of freedom), and held in the proper orientation on the abdominal wall while the mesh is fixed to the abdominal wall with a mechanical fixation device and/or sutures. The device is then released from the mesh by pulling a lever on the handle, and removed. Additional sutures can then be placed as appropriate. The Echo PS™ device (CR Bard; Warwick, RI) utilizes two parts. A mesh rolling device aids in insertion, and a balloon frame that is attached to the mesh is then inflated after retrieving the tubing and pulling it through the center of the coverage area, typically the center of the defect, which places the mesh flush against to the abdominal wall. The device/mesh is held taut while a mechanical fixation device and/or sutures are used to attach the mesh to the abdominal wall. The frame is then deflated and removed by simply pulling it out through a cannula with a grasper. Additional full thickness sutures are then placed where appropriate. These devices are depicted in Fig. 7.3. Most recently released is a new expandable frame made of nitinol, rather than a balloon [19]. This Echo 2 (Bard, Inc. Warwick, RI) device has fewer steps than the balloon-based frame, and accomplishes the same task (Fig. 7.4).

Mesh Fixation

There are two types of mesh fixation. The first is how the surgeon connects the mesh to the tissue in the operating room, and the second is how the body connects the mesh to the tissue as part of the healing process. To date, there has been no consistent data to suggest one fixation method is better than another. Full thickness anchoring sutures that traverse the mesh, and all layers of the abdominal wall except the skin and most subcutaneous tissue are considered the strongest of all surgical applied fixation methods [20, 21]. There are a variety of mechanical anchoring devices on the market, most of which are helical fasteners that resemble a screw. One fastener has a "U" shape with barbs at the tips to hold it in place, and one resembles a suture, encircling the tissue and mesh, with the ends connected similar to a zip tie. The mechanical devices can deliver both permanent and absorbable fasteners, depending on the version. These types of mechanically delivered fasteners are not as strong as full thickness abdominal wall sutures, because they only go through a portion of the abdominal wall muscle and fascia. There has been no proven benefit of one fixation fastener

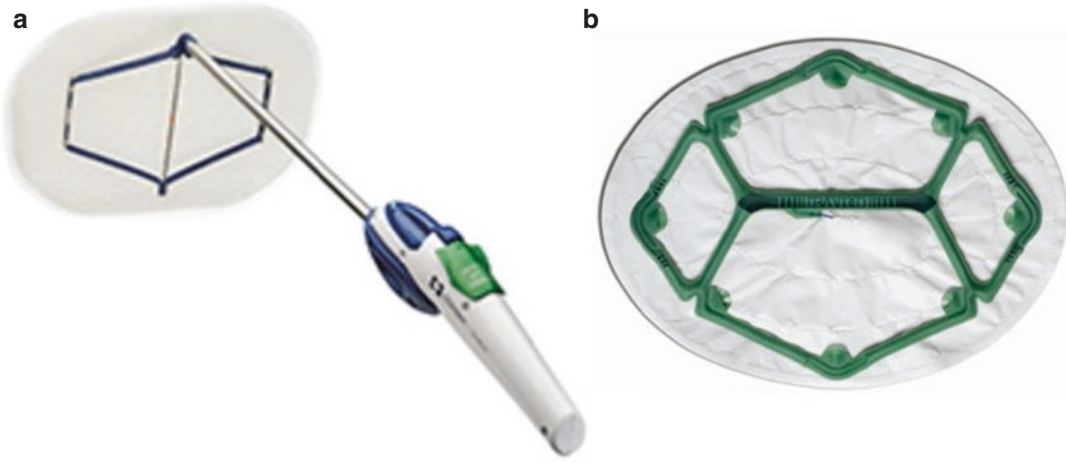

Fig. 7.3 Mesh introduction and positioning systems. (**a**) Medtronic AccuMesh™ device assists with introduction of mesh, mesh spreading with an expandable frame, and positioning using an articulating shaft with 4 degrees of freedom. (**b**) Bard Echo PS™ device utilizes a separate introduction device, and assists with unraveling and placement of the mesh over the defect with a balloon frame, inflated via a central catheter pulled out through the center of the defect

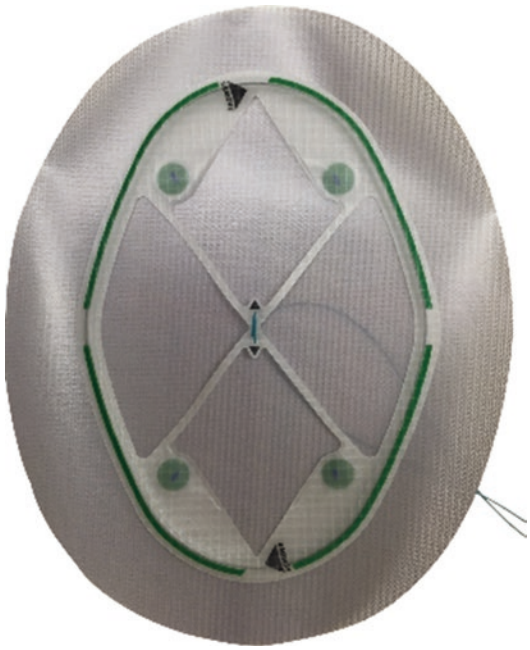

Fig. 7.4 Bard Echo 2™ device utilizes an accessory introduction device, and assists with unraveling and placement of the mesh over the defect with a nitinol frame. The mesh is pulled up to the abdominal wall through the center of the defect with the attached "hoisting" suture, and is removed after fixed to the abdominal wall by simply pulling the frame through a cannula with a grasper

over another, and new fasteners are continually being introduced to the market in an attempt to continuously improve this aspect of laparoscopic ventral hernia repair [22]. Examples of these fasteners can be seen in Fig. 7.5. Finally, it has become popular among users of robotically assisted surgical devices to use a variety of suture types to connect the mesh to the abdominal wall, with a variety of suturing patterns and suture depths. Because the technique is manual, and operative circumstances not uniform, it is unknown how strong and predictable this fixation method will ultimately be. Furthermore, suture choice and suture pattern are highly variable among surgeons, making a comparison to existing methods of fixation difficult at best. However, whatever the depth and pattern the sutures are placed, they will largely be placed through a partial thickness of the abdominal wall, and thus less strong compared to full thickness sutures [23, 24].

Hernia mesh fixation is obviously necessary, but not without complications. Full thickness sutures can cause long-term pain requiring trigger point injections and/or suture removal, and helical tacks can cause postoperative bowel perforation, adhesions, and additional hernia defects [25–27].

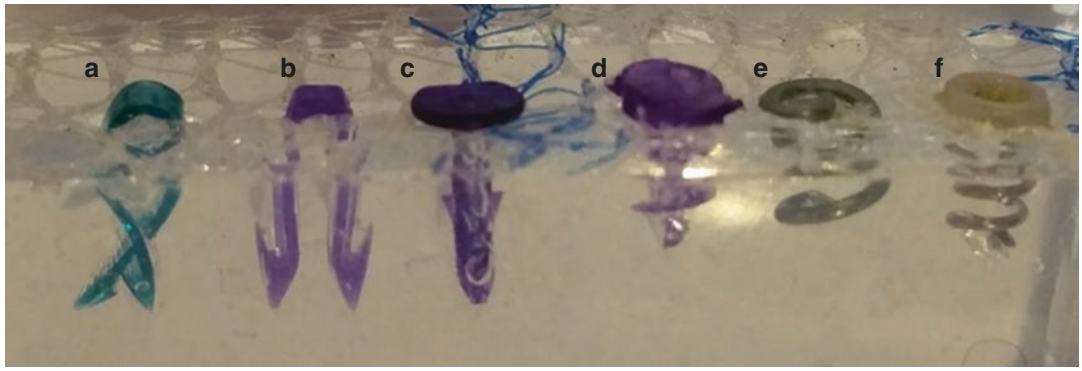

Fig. 7.5 Mesh fixation products. (**a**) Suture-like fixation, permanent (FasTouch™, Via Surgical, Amirim, Israel), (**b**) "U"-shaped fastener, absorbable (Secure Strap™, Ethicon, Cincinnati, OH), (**c**) Barbed nail-type fastener, absorbable (Optifix™, Bard, Warwick, RI) (**d**–**f**) Helical fasteners, ((**d**, **e**) Absorbatack™-absorbable and ProTack™-permanent, Medtronic, Minneapolis, MN; (**f**) CapSure™, Bard, Warwick, RI-permanent)

Long-term pain has not been shown to be clearly related to partial thickness fasteners deployed laparoscopically, or full thickness sutures [28].

In an attempt to avoid the potential postoperative complications from permanent fixation methods, absorbable fixation devices have been developed, and are popular among surgeons. Since the currently available absorbable fasteners take up to a year to absorb, it is unlikely that an absorbable fastener placed through a nerve will allow for nerve regeneration and healing after absorption. Also, the incidence of tack pain is extraordinarily low, given the millions of permanent helical tacks that have been placed, and the rarity of removal with successful pain relief. A study from Denmark published in 2015 examined 816 patients after LVHR, and showed no effect on long-term pain with absorbable tacks compared to permanent tacks [29].

Additionally, absorbable fasteners are thought to be less prone to adhesions. However, adhesions to permanent and absorbable screw-type fasteners were found to be equal at 4 weeks postoperatively in a porcine model [30]. Consider however small bowel, which is perfectly biocompatible. Small bowel can adhere to itself, which is most likely due to tissue trauma. It is certainly possible that adhesions to fixation points may be more related to tissue injury related to the profile of the fastener exposed to the bowel, rather than the absorbability or raw material of the fastener.

Furthermore, absorbable fixation alone will rely on tissue integration as the sole method of mesh fixation in the long term. Since the host tissue response is unpredictable, the strength of the long-term fixation will be more variable, and the mesh:defect ratio becomes more important. Indeed, at least one study of 816 patients from Denmark revealed higher recurrence rates when using absorbable, rather than permanent fasteners [29].

The host response to the foreign body also will fixate the mesh to the anterior abdominal wall during the postoperative period. This process however is much less predictable than the surgical fixation placed in the operating room. As collagen is deposited and remodeled throughout the interstices of the mesh, a greater contact surface should increase the overall strength of the tissue incorporation aspect of the mesh fixation. Closing the defect with the mesh flat against the tissue, without buckling, would obtain a greater contact area.

Mesh Coverage

A common concern among surgeons is the optimum amount of "overlap" required to prevent recurrence. The term refers to the distance between the edge of the defect and the edge of the mesh covering the defect. The problem with this

concept is that this distance is a linear measurement that is used in the context of a nonlinear environment, and does not take into account mesh fixation technique/location, and tissue ingrowth. Despite this, it has been shown that increasing the overlap is associated with decreased rates of recurrence [31].

A better perspective may be to consider the ratio of the mesh size to the defect size, the type and relative strength of the fixation, and the clinical scenario regarding the patient's weight and fat distribution, activity level, size and location of the hernia defect, and whether or not the defect is closed. Since it is impossible at the current time to measure the relative importance of these factors, and even take precise measurements in the operating room, the surgeon should size the mesh based on all of these factors, and not just consider the number of centimeters between the defect edge and edge of the mesh. By way of example, the forces exerted on a mesh covering a 10 cm circular defect are different than those from a 4 cm defect. If both size defects are covered with a mesh that has a 5 cm overlap with the same fixation techniques, the mesh covering the 10 cm defect will be subject to larger forces at the fixation points, and theoretically have an increased risk of recurrence compared to the 4 cm defect, despite a 5 cm "overlap". Therefore, known risk factors for recurrence such as larger defect size, obesity, and recurrent nature of the hernia should demand a higher mesh:defect ratio in order to mitigate the increased risk of recurrence to the best of our abilities, as shown conceptually in Fig. 7.2 [32].

Exiting the Abdomen

At the conclusion of the operation, there is often a sigh of relief, a natural human tendency after a period of intense concentration. While not related to the hernia repair itself, it is important to run through a brief checklist prior to exiting the abdomen (Table 7.2). First, look for any ongoing bleeding. This will necessitate an intentional look around the peritoneal cavity, particularly in dependent areas that have been out of the field of view. Areas covered in clot that seem to be thick may need to have at least some of the clot evacuated in order to inspect the underlying area for active bleeding. The next area of inspection should be of the GI tract, particularly areas involved in the adhesiolysis. The intensity of the inspection will be dependent on the surgeon's judgment and intimate knowledge of the operation. Additionally, one should laparoscopically inspect all the port sites after the cannula is removed to inspect for bleeding that may have been tamponaded by the cannula, and need for fascial closure [10]. Finally, the mesh may be inspected as the pneumoperitoneum is evacuated, in an attempt to make sure no intraperitoneal contents slip between the mesh and the abdominal wall. While the order and diligence of the final inspection will vary according to clinical scenario, it is generally a good idea to dictate this into the operative report.

Table 7.2 Checklist prior to exiting the abdomen after LVHR

Task	Rationale
Inspect peritoneal cavity for ongoing bleeding-dependent areas (particularly areas out of the field of view), areas under a large clot	Avoid postoperative hemorrhage
Inspect bowel (particularly areas involved in adhesiolysis)	Avoid missed enterotomy
Inspect port sites after cannula removal	Avoid postoperative hemorrhage and assess need for fascial closure
Inspect mesh while evacuating pneumoperitoneum	Avoid peritoneal contents slipping between mesh and abdominal wall

The order and diligence of the final inspection will vary according to clinical scenario. It is generally recommended to dictate this final inspection, or reason why it was done, in the operative report

Conclusion

The choice of a laparoscopic approach to ventral hernia repair should come from an algorithmic approach that puts the patient's goals and specific clinical situation at the top of the list in terms of importance. *The choice to*

proceed with LVHR should not be made simply on the basis of the desire to use a specific surgical device. Once the choice is made, adhesiolysis should be accomplished with fundamental laparoscopic techniques, including the use of proper ergonomics, sparing/careful use of an energy device, and inspection of the GI tract after adhesiolysis is completed. Careful assessment of the hernia should include operative exposure and inspection of the defect and surrounding abdominal wall in order to look for occult hernias, and allow placement of an appropriate size mesh flat against the abdominal wall. Midline hernias for example, may have a punched out, circular defect of 3 cm, but may be associated with a surrounding elliptical area between the rectus muscles of 5 cm transverse × 8 cm vertical. The abdominal wall deficit should be considered to be the elliptical area between the rectus muscles, not just the punched out defect through which abdominal contents can herniate. Closure of the defect will increase the surface area the mesh is in contact with, and reduce seroma rates, but has not been shown to improve long-term outcomes such as recurrence. Rather than using the linear measurement of "cm of overlap" to select mesh size, consider the mesh:defect ratio, with a tendency to use higher ratios for cases with higher risk for recurrence, such as larger defects, obese patients, and recurrent hernias. The amount and type of fixation will depend on the size of the defect, and whether or not the defect was closed. Stronger and increased amount of fixation should be used for larger defects that are bridged, compared to smaller defects that are closed.

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