Considerations in Selecting Mesh For Hernia Repair:
Evaluating the Role of a Hybrid Hernia Device

In the United States, hernia repair is one of the most common surgical procedures with more than 400,000 ventral hernia repairs (VHRs) performed annually.¹,² With the advent of laparoscopy, the majority of hernia repairs now use surgical mesh to stabilize the abdominal wall and help prevent recurrences.¹,³ The current armamentarium of mesh abounds with more than 200 options varying in composition, weight, and price, along with its own utility in different patient scenarios and surgical fields.⁴,⁵ Mesh is classified as being permanent synthetic, biologic, or bioabsorbable based on its composition and behavior in the body. Each class of mesh was developed to address an unmet need of a predecessor and continues to evolve to facilitate the wound-healing process and optimize cell growth and angiogenesis, while accounting for different patient populations and surgical environments.

Despite the availability of different types of mesh, no one type has yet to prove applicable to all patients or hernia repairs.⁶ Consequently, there is no consensus on the use of these materials.⁶,⁷ Surgeons are tasked with having to select the most appropriate mesh to repair and reinforce the abdominal wall, while minimizing the rate of recurrence, optimizing the patient’s quality of life (QoL), and containing costs. The current mesh portfolio features different materials that have demonstrated some degree of efficacy in hernia repair; however, each material poses risks or drawbacks that may limit use. With the recent approval of Zenapro, a hybrid hernia repair device indicated for clean and clean-contaminated fields, the mesh spectrum has expanded to include a product that encompasses distinct features of a synthetic and biologic to allow a positive cellular response while minimizing complications.
This monograph outlines the benefits and challenges of the different classes of mesh for hernia repair, and introduces Zenapros as presented at the 6th Annual Abdominal Wall Reconstruction Conference in Washington, DC.

Considerations in Selecting Mesh For Hernia Repair

The ideal mesh for hernia repair is contingent on many variables, not the least of which are patient characteristics, such as age, and the presence of underlying disease and comorbidities. How successful a repair also depends on the rate of recurrence, the risk for complications, optimal QoL, and cost-effectiveness (Table 1).

Recurrence is an important outcome measure for hernia repair; high-tensile strength mesh reinforces the abdominal wall while preventing recurrence. Use of mesh for hernia repair has been shown to reduce recurrence by 50%. However, each mesh possesses distinct biomechanical properties (eg, material, weight, pore size, elasticity, degradability) that affect its fixation to the abdominal wall.

Complications

Infection is one of the more common complications of hernia repair using mesh. Infection increases morbidity and, consequently, health care expenditures associated with readmission and additional treatment and resources.

Adhesions have become a greater concern with the increased popularity of laparoscopic intraperitoneal mesh placement. Initially, adhesions form as a result of the body’s response to injury to the mesothelium, which sparks a cascade of events that begin with fibrin deposition. Ideally, fibrinolysis in the abdomen will prevent adhesions from forming; however, the use of some types of materials may hamper fibrinolysis. Placement of the mesh near the bowel may result in obstruction, adhesions, and fistula formation.

Quality of Life

Successful hernia repair reduces the risk for recurrence as well as the potential for other complications that can affect a patient’s QoL. Adverse outcomes such as infection may increase pain and discomfort, as well as the patient’s ability to perform daily activities. Chronic pain has been shown to occur in up to 30% of hernia repairs, and significantly affects patient mobility.

Table 1. Characteristics of an Ideal Mesh

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<th>Description</th>
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<tr>
<td>Cost-effective</td>
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<tr>
<td>No potential for adhesion</td>
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<tr>
<td>Optimal tissue integration</td>
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<tr>
<td>Minimal shrinkage</td>
</tr>
<tr>
<td>No risk for infection</td>
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<tr>
<td>Does not limit patient mobility</td>
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<td>Easy to use</td>
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Based on reference 3.

Costs

Complications associated with hernia repair, including recurrence and infection, can affect overall health care costs significantly. Additional repairs may require readmission, hospitalization, and other resources. A recent study showed that a mesh infection could result in $44,000 in inpatient hospital charges along with $63,400 in follow-up costs. Poulose and colleagues assessed the total costs for hernia repairs based on 348,000 procedures performed for VHR between 2001 and 2006. The results showed that procedural costs increased steadily during the study, totaling $3.2 billion. It was concluded that every 1% reduction in recurrence would result in an annual savings of $32 million in procedural costs.

Assessing the Mesh Portfolio

With limited long-term and comparative data as well as no consensus on the different tissue-reinforcement materials, surgeons will need to evaluate the benefits and drawbacks of each material to assess it in terms of the repair, patient response, surgical field, risk for complications, and associated costs.

Permanent Synthetic Mesh

When performing hernia repairs, surgeons overwhelmingly rely on synthetic meshes, which have evolved considerably since the debut of polypropylene mesh more than 50 years ago. Today’s synthetics come in a variety of weights and sizes, are easier to use than their predecessors, and have been shown to reduce the rate of recurrence when compared with other surgical techniques such as suture-only repair. To assess the efficiency of synthetic mesh, Luijendijk and colleagues randomized 200 patients undergoing repair for either a primary hernia or a first recurrence to synthetic mesh or suture-only repair. Results showed that repairs made with a synthetic mesh resulted in a significantly lower recurrence rate compared with primary suture repair even 3 years after repair.

With synthetic meshes, the inflammatory response that ensues after implantation can lead to in-growth by “scarring in.” However, synthetic meshes can be associated with complications, including infection, adhesion formation, bowel obstruction, fistula formation, and erosion. Potential for such complications limits the use of synthetic mesh in clean-contaminated and contaminated surgical fields where the risk for complications would be greater.

In a retrospective cohort analytic study, Leber and colleagues evaluated 200 patients undergoing open incisional hernia repair using 1 of 4 different types of synthetic meshes to assess the extent of short- and long-term complications. Results showed that 36 (18%) patients experienced short-term complications and 54 (27%) experienced long-term complications (Table 2), most notably recurrence and chronic infection. A retrospective review of 176 patients undergoing elective hernia repair using a permanent synthetic found that the overall infection rate was 8% with a 49-day median time to infection. Adhesions are another challenge with synthetics. Fibroblasts invade the synthetic mesh’s provisional matrix and begin to lay down new tissues and blood vessels. If there is contact with a myofascially injured organ, an adhesion with vascularity and tenacity may result.

Although a patient may avoid an early adhesion, it is possible to develop a late adhesion or bowel obstruction caused by the mismatch between the synthetic material and the patient’s own
tissues. For example, heavyweight meshes spark intense fibrotic reactions. These reactions result both in the intended effect of strong adherence to the abdominal wall and the unwanted effect of the development of dense adhesions. Microporous expanded polytetrafluoroethylene (ePTFE), on the other hand, prevents tissue in-growth, which has the dual effects of weakening the adhesion to the abdominal wall with very low risk for adhesion formation.11

In an attempt to minimize the risk for adhesions, composite or barrier-coated synthetics have been developed to reinforce the repair and strengthen the abdominal wall. These include polypropylene with omega-3 fish oil; polypropylene with polyglycolic acid and hydrogel; polypropylene with submicron ePTFE, polyester with purified collagen; and polyethylene glycol and glycerol.18

**Biologic Grafts**

Grafts derived from the extracellular matrix (ECM) of biologic tissue (ie, human or animal dermis, bovine pericardium, or porcine submucosa) have been available for 15 years.19 Biologic grafts are extracellular scaffolds into which host cells can repopulate. Most biologics are designed to leave behind a minimal amount of foreign material, reducing the risk for inflammation and infection associated with permanent synthetic mesh.20

Although biologic grafts are cleared for standard repairs, they often are used in challenging and complex repairs, such as grossly contaminated fields, that deem other mesh to be ineffective. Results from the RICH (Repair of Infected or Contaminated Hernias) study showed that after 2 years more than 70% of patients had experienced a successful VHR using a non–cross-linked, porcine acellular dermal matrix in a contaminated surgical site; 28% of patients had experienced recurrence and 30% developed an infection.21

Recently, Moreno and colleagues presented data from a 13-year study on the recurrence rate for repairs using small intestinal submucosa (SIS) grafts.22 Of 344 procedures, 17 recurrences were reported over the course of a 10-year follow-up.23 With only 2 wound infections, and a 5% recurrence rate, SIS grafts were deemed safe and a feasible option for hernia repair in contaminated or potentially contaminated fields with a minimal recurrence rate and satisfactory results with long-term follow-up.22

Biologic grafts pose several challenges that should be evaluated. Because the graft is derived from biologically derived materials, it is difficult to predict a patient’s response to it.20 Regardless of its source, the biologic tissue undergoes a series of treatments for biocompatibility and resistance to rapid enzymatic degradation that may affect the mesh’s tensile strength.20 These processes also may increase the risk for potential inflammation or response to foreign matter that may affect cellular response.25 Because dermal-biologic grafts stretch similarly to human skin, cross-linking is applied to reduce the elasticity; consequently, the cross-linked graft can resemble a foreign body material that promotes neither incorporation nor remodeling.13

Although biologic grafts have been shown to reduce the risk for infection and recurrence, particularly in contaminated environments, it also is more expensive with direct costs doubling those associated with synthetic mesh.2,23 Biologics can range from $16 to $30/cm² compared with permanent synthetics that range from $2 to $8/cm².26 Reynolds and colleagues showed that the use of biologic graft totaled $16,970 in direct inpatient procedural costs compared with $7,590 for procedures using synthetic mesh.23 Thus, the use of a biologic graft is difficult to justify except in the most warranted cases, where placement of a permanent synthetic mesh would result in complications that would require further surgical interventions and thus greater expenses.18,23

**Bioabsorbable Mesh**

Known as biosynthetic or bioabsorbable, these synthetic materials are designed to provide a matrix or scaffolding for tissue in-growth in the abdominal wall.24 Bioabsorbable meshes use biodegradable polymers for repopulation of host cells, which are absorbed and eliminated, minimizing the risk for long-term complications associated with other materials.24

The extended absorption rate of bioabsorbables offers more time for complete tissue integration.

Additionally, bioabsorbables are available in different sizes, including large sheets, to ensure consistency and to facilitate handling.25

Because bioabsorbables involve revascularization, the scaffold is able to resist infection, making it a more appealing for hernia repairs in contaminated environments than synthetics24; however, bioabsorbables are best used as a temporary repair, in a contaminated field where primary abdominal closure is impossible to achieve, or in a patient whose infection must be managed expeditiously in order to undergo a permanent repair at a later date.26

**Applying a Hybrid Hernia Repair Device**

Recently, Wolf and colleagues suggested that when a synthetic mesh is coated with an ECM, the body’s response to the foreign material is more favorable than when it encounters a pure synthetic material.27 Specifically, the presence of the ECM attenuates the M1 macrophage response, which is more of a rejection response, while increasing the M2 macrophage response, which is more of an accommodation response.27

Cook Medical has developed Zenapro, an SIS/polypropylene hybrid mesh that merges the optimal qualities of biologic and synthetic meshes to reinforce the abdominal wall: a positive host response and a strong and durable repair (Figure 1).

![Image](https://via.placeholder.com/150)

**Table 2. Early and Long-Term Complications With Synthetic Mesh**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number of Patients, %</th>
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<tbody>
<tr>
<td><strong>Early complications (&lt;1 mo)</strong></td>
<td></td>
</tr>
<tr>
<td>Cellulitis</td>
<td>7</td>
</tr>
<tr>
<td>Postoperative ileus</td>
<td>8</td>
</tr>
<tr>
<td>Wound drainage</td>
<td>4</td>
</tr>
<tr>
<td>Hematoma/seroma</td>
<td>3</td>
</tr>
<tr>
<td><strong>Long-term complications (&gt;1 mo)</strong></td>
<td></td>
</tr>
<tr>
<td>Recurrence</td>
<td>16.8</td>
</tr>
<tr>
<td>Chronic infection/sinus tract</td>
<td>5.9</td>
</tr>
<tr>
<td>Small bowel obstruction</td>
<td>5.4</td>
</tr>
<tr>
<td>Enterocutaneous fistula</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Based on reference 17.
Zenapro consists of a lightweight, macroporous polypropylene that is compliant with the microporous structure of a porcine SIS-derived ECM that protects viscera from the polypropylene component, while enhancing tissue deposition of healthy host tissue around the mesh. The dynamic of both materials allows for a beneficial host response for an optimal repair in clean and clean-contaminated surgical sites.28

Zenapro is highly biocompatible and allows for remodeling on both sides of the mesh. Also, consisting of 7 layers (2 layers of SIS, 1 layer of polypropylene, 4 layers of SIS), Zenapro uses an ultra lightweight polypropylene, that, when paired with SIS, has a density of a heavyweight mesh (Figure 2).

To determine the most effective way to layer the 2 materials, 4 different configurations using varying numbers of SIS layers on either side of the synthetic were studied in 52 rat models. The results showed that 3 of the 4 configurations worked equally well in terms of preventing adhesions formation; however, when assessing percentage of the meshes covered with adhesions, a greater number of SIS layers on the inside of the synthetic resulted in deposition of a tissue layer that protected the bowel from the mesh. Extrapolating from that study, the final configuration deemed most appropriate for use in humans consisted of 4 layers of SIS on the inside, the viscera-facing portion of the mesh, and 2 layers on the outside.29

Data

Researchers conducted a bilateral implant study of 6 rabbits to compare Zenapro’s prototype with Ventralight ST (Davol), a barrier-coated synthetic. At 3 months, there was minimal tissue deposition on the Ventralight ST mesh, whereas Zenapro was coated with almost an entire millimeter of new tissue. At 6 months, tissue deposition on the barrier-coated mesh had increased, but was still superficial, whereas the SIS-coated mesh was buried under several hundred microns of tissue mid-graft, with tissue deposition being even thicker at the edges (Figure 3). It is probable that the lack of tissue deposition on the Ventralight ST mesh would result in a late-stage adhesion caused by abdominal exposure to the rough surface.29

To further investigate the Zenapro device, a multicenter trial is ongoing with more than 60 patients expected to enroll. Patients undergoing ventral/incisional hernia repair in laparoscopic or open repairs will be repaired using Zenapro in both clean and clean-contaminated environments, including many challenging hernia patients. The first 30 patients have been enrolled, and an interim analysis of the data is expected to be released at the 2014 American College of Surgeons Clinical Congress. For information regarding the ongoing clinical trial, please visit ClinicalTrials.gov (Identifier: NCT01784822).

Conclusion

Surgical mesh repair is the most common technique for repairing and reinforcing the abdominal wall. Despite the availability of several classes of mesh material, the associated risks and costs render the need for new options. Zenapro is a unique alternative that synergizes polypropylene with layers of SIS to create a biocompatible implant that may improve tissue deposition while minimizing risks for recurrence and complications.
Zenapro is currently undergoing a postmarketing observational study to collect data on its performance in the repair of ventral hernias and when used to bridge or reinforce the abdominal wall. The study is expected to be completed in December 2015. In anticipation of the results, several experts in the field with experience using Zenapro were asked to provide insight on the role of hernia repair, and the current mesh portfolio, including the pending release of Zenapro.

1. Describe briefly where and/or when you currently use an uncoated synthetic, a coated synthetic, an absorbable synthetic, and a biologic graft.

**Dr. Yoo:** I use an uncoated synthetic mesh during procedures where I will have intramuscular or retromuscular placement of the prosthetic, only in a place where it does not have any contact with the bowel. I use coated synthetics as an underlay in the intraperitoneal position for open and laparoscopic VRHs. The coating will protect against adhesions, so it is fine for the mesh to have contact with the bowel. I currently use absorbable synthetic meshes in patients for whom a prosthetic mesh may not be ideal, such as women of childbearing age or patients who may require subsequent surgeries. There also is patient preference to consider—some do not want to have a permanent mesh. Finally, and this is a growing trend, I use an absorbable synthetic in clean-contaminated settings where I would like to use a biologic mesh, but can’t because the biologic mesh is cost prohibitive. In this scenario, if the mesh does become infected, it does not need to be removed because it will be absorbed over time. I use biologic meshes in clean-contaminated or contaminated settings. Biologic meshes have become a bit more pliable, which makes them advantageous in procedures such as a colostomy repair where I am using the Sugarbaker technique, or during a hiatal hernia repair. These are situations where I really need the mesh to conform and have good contact with the tissue.

**Dr. Hope:** I use an uncoated synthetic mesh when I am not placing mesh intraabdominally for the majority of all clean cases and most of my clean-contaminated cases. My bias is to place it in the retromuscular or retromuscular space. I typically use coated synthetic meshes when I’m placing mesh intraabdominally in a laparoscopic procedure, most commonly in a laparoscopic VHR, or very occasionally in an open repair where I can’t do a retromuscular placement. I rarely place this type of mesh intraabdominally. Currently, I am using absorbable synthetic meshes in patients who are at high risk for wound infections, such as smokers and those who have diabetes. I also use it selectively in some clean-contaminated cases. My use of biologics is limited to catastrophic abdominal cases, such as when I have an extremely sick patient who has a contaminated field. On rare occasions, I bridge the fascia with biologic mesh.

**Dr. El-Hayek:** I use an uncoated synthetic mesh in the inguinal space in an open or laparoscopic procedure where there will be no mesh exposed to the intraabdominal cavity. I also use it in a retromuscular position during an open VHR. I use coated synthetic mesh anytime the mesh may be exposed to the intraabdominal cavity. I use absorbable synthetic mesh in large hiatal hernia repairs, I also use them in cases where I am not able to fully approximate the fascia in a contaminated or damage-controlled setting, where I want coverage of the bowel but am not able to get fascial coverage. I use biologic mesh in a grossly infected field or if there is some other contraindication to using a synthetic mesh, such as patient allergy or previous rejection. I typically try not to do this, but I sometimes use a biologic to bridge in very rare situations when I’m concerned about fistula with the use of an absorbable synthetic mesh.

**Dr. Bittner:** I use non–barrier-coated, permanent synthetic meshes in clean and select clean-contaminated open cases in the retromuscular, retrorectus, or sublay position, but very rarely in the onlay position, for ventral and incisional hernia repairs. I also use this type of mesh in open and laparoscopic inguinal hernia repairs in clean and some clean-contaminated cases. As far as barrier-coated synthetic meshes are concerned, I have used those in the open and laparoscopic intraperitoneal location for ventral and incisional hernia repairs in clean cases. I have also used a barrier-coated permanent synthetic mesh in laparoscopic Sugarbaker repair with double hernia repairs. I’ve used absorbable synthetic meshes in the open retromuscular position as well as the onlay position for ventral and incisional repairs.
in clean and contaminated cases within the setting of clinical trials. I also use them in open procedures as a sort of prophylaxis for retromuscular reinforcement, and for laparoscopic paraesophageal hernia repair in select cases. I use biologic meshes in open ventral and incisional hernia repairs placed in the retromuscular, intraperitoneal, and onlay positions. In contaminated or grossly contaminated cases I use them for laparoscopic repair in the intraperitoneal position for postoperative hernia repair. I have also used biologic grafts in parastomal hernia repairs for selected cases.

2. What are your thoughts on the use of biologics for abdominal wall repair in complex clean fields or potentially contaminated (level 2) fields?

Dr. Yoo: The biggest concern right now is the increased recurrence rate we see with biologic meshes compared with synthetic meshes. Biologics have always been associated with higher recurrence rates, but they are used in complicated situations (ie, in contaminated fields, in very sick patients, in urgent situations) and outcomes with those [types of cases] are often bad. But synthetic mesh can cause horrendous problems, for instance, when a large piece of synthetic mesh becomes infected. If you remove that prosthetic mesh, your patient may not have an abdominal wall for the rest of his or her life. To avoid these uncommon but catastrophic situations, the ideal mesh would help the abdominal wall get stronger and eventually—a year later—no longer be there to create complications. I have gone from following that suit to using biologic mesh more selectively because cost is a major issue.

Dr. Hope: There may be a small role for biologic meshes in clean cases, especially in research protocols in a very select patient population, but I lean more toward using synthetics in those cases. With biologics, I have some concern about their cost as well as their efficacy.

Dr. El-Hayek: At this point, I think we simply need more data to figure out the right use for biologics. There has been some good data to support [the use of] macroporous lightweight synthetic mesh as a potentially better and cheaper option in those situations where biologics are being used currently.

Dr. Bittner: We know from the data that biologic grafts in any field have higher long-term hernia recurrence rates compared with synthetic grafts, especially with regard to the technique in which they are employed; a bridging technique results in a potentially immediate recurrence. When used with an appropriate technique, biologic meshes can yield fairly acceptable outcomes, but still not comparable to the outcomes we get with a synthetic mesh. I think unless you have significant contamination that warrants the use of a biologic graft, a synthetic would be the way to go to prevent long-term hernia recurrence.

3. What are the pros and cons of using a synthetic mesh in abdominal wall repair?

Dr. Yoo: Multiple studies have shown that synthetic meshes lower the [hernia] recurrence rate. The manufacturers have done a good job of changing the properties of synthetic meshes to make them more pliable, lightweight, and easy to handle in an open setting. Of course, they cost much less than biologic mesh, although the cost of synthetics has been going up. The con is that if there is a recurrence, when you reoperate you have to take that first piece of mesh out. If you put mesh on top of mesh, the second piece is not going to incorporate very well and you will be setting the patient up for a third recurrence. This really puts the burden on the reoperative surgeon to do the right thing—to take that mesh out before placing new mesh. The problem is, a lot of surgeons don’t do that.

Dr. Hope: Among the pros of using a synthetic mesh is that it has a fairly long track record, since the 1950s, and a fair amount of data with efficacy. The synthetic mesh tends to have a fairly good profile as far as recurrence rates. The cons of using a synthetic mesh are that it is a permanent foreign body and there are a lot of potential long-term problems, such as infection, adhesions, and sometimes QoL issues that come along with that.

Dr. El-Hayek: The pros are that synthetic mesh are strong and cost-effective materials. I think the outcomes have been very good—they have been shown to decrease recurrence rates compared with a primary closure. Potential foreign body reaction is a major drawback to using synthetic mesh.

Dr. Bittner: The main pro to using synthetic mesh is a lower risk for hernia recurrence in the long term. Depending on the type of synthetic mesh being used, there also is less potential for seroma formation than with a biologic. Synthetics are permanent, so they alleviate tension on the abdominal wall, hopefully in a permanent nature, whereas a biologic may stretch over time. The cons of using a synthetic in abdominal wall repair include the potential for (a) long-term chronic infection, (b) need for explantation of the mesh, and (c) chronic pain associated with a permanent synthetic mesh.

4. What criteria do you use when selecting a mesh for laparoscopic VHR? Are the current barrier coatings doing enough?

Dr. Yoo: First, pliability is key because people do a lot of twisting and moving, and once the mesh has adhered to the abdominal wall patients should be able to do all of those things without having the mesh inhibit their movement. Second, the mesh must be able to take tacks very well. Some meshes are pliable because they are very lightweight, but tacks just go right through them. The answer to the second part is yes. I have had a lot of second looks during laparoscopic VHR, and the barrier-coated meshes I’ve used have protected against adhesions in the long run.

Dr. Hope: For VHR, I lean toward using a coated mesh because I’m placing the mesh intraabdominally. My choice of mesh depends on the type of repair. Now, I more commonly try to close some of the smaller defects with a midweight coated mesh. In smaller defects, when I’m just using a laparoscopic repair as a bridge, I’m starting to lean a little bit away from the lighter meshes to a midweight mesh. I usually use a coated polypropylene and polyester mesh in those cases. As far as whether they’re doing enough, [the answer is] yes and no. I think the current barrier-coated meshes are fairly good at preventing intestinal fistulas, which are the most dreaded complication of an intraabdominal mesh. On the other hand, I think almost all of these coated meshes will still form a moderate amount of adhesions in the abdomen, so that remains a problem.

Dr. El-Hayek: If it is a clean case, I use a synthetic permanent mesh as long as I can get coverage of at least 3 to 5 cm around the hernia defect. In response to the second question, animal studies have shown that the coated portion of a composite mesh becomes covered with peritoneum at a reasonable time interval. In patients with prior composite mesh placed, on repeat operations, I have seen intraperitoneal coverage. I think...
the key, and this is my main point, is that technique is paramount when it comes to any type of hernia repair surgery. Getting fascial reaproximation wherever possible and circumferential mesh fixation is critical. I prefer transfascial suture fixation to really get the edges approximated to the abdominal wall so the mesh will achieve peritoneal coverage.

**Dr. Bittner:** An absorbable, barrier-coated synthetic mesh would be my first choice for clean cases in laparoscopic VHR. I use that in conjunction with primary closure of the defect to try and ensure the lowest possible hernia recurrence rate. The reason I select that laparoscopic approach in most patients is due to underlying comorbidities where the potential for infection may be high or because the defects are relatively small and may do fine with a primary transfascial tissue closure and intraperitoneal mesh placement. At this point, I think the meshes can do better. We have some good data on explant material showing that short-term adhesion can be lowered using the barrier coating. What we don’t know as well is the potential for adhesions in the long run. I think it would be good if the barrier coatings on the visceral side would last a little bit longer as you might find with a biologic coating, and yet still allow for mesh—tissue interface and tissue incorporation of the synthetic material on the peritoneal side.

5. **What advantages would you expect from a hybrid synthetic/ECM like Zenapro?**

**Dr. Yoo:** Ideally, I would expect the best of both [synthetics and biologics] without the negatives of either mesh. But that’s wishful thinking. What I’m hoping for at the least is that I would have the long-term durability of a synthetic mesh and that it would stay there long enough to really integrate with the abdominal wall. Biologic meshes work through a process of regeneration and degradation, both of which depend on patient qualities. In some patients, the mesh stays around long enough for the abdominal wall to get strong. Ideally, a year later that mesh would be gone and not last to create any complications. But some patients never have integration with the mesh itself, and sometimes the reabsorptive process is faster than the regenerative process. The synthetic material could help ensure that the abdominal wall maintains its conformation while allowing the biologic material to do its thing.

**Dr. Hope:** I think the advantage would be a marriage of the merits of each. The presence of biologic material should help with the scaffold—the in-growth of the body’s native tissues—and the strength and long-term durability of the synthetic mesh would keep recurrence rates low.

**Dr. El-Hayek:** We are trying to figure out if there is any advantage in usability—if it will be easier to use—and if the potential for incorporation will limit the amount of foreign material that is ultimately left in the body. This would mean a potential decrease in foreign body reactions, mesh infections, and bowel-related complications. Those are the broad ideas in terms of what its use may be and what we might see.

**Dr. Bittner:** An advantage I would expect is that with the biologic material serving as a [longer-lasting] barrier coating there would be a potential to reduce adhesion [formation]. [The biologic barrier] also may stimulate tissue in-growth on the peritoneal side if you’re using a laparoscopic approach, or it may stimulate tissue in-growth when placed against muscle in the retrorectus or preperitoneal approach; this could help the mesh incorporate slightly sooner. Finally, although we have no data [on this] yet, I would hope the barrier coating from a biologic mesh may allow us to treat mesh infection with antibiotics and avoid explantation of mesh.

6. **In what procedures would you see a role for a hybrid synthetic/ECM like Zenapro?**

**Dr. Yoo:** If price weren’t a factor I would use it in every standard laparoscopic VHR. The problem I have with prosthetic mesh is that it is purely a foreign material and there is nothing to induce the body to develop healthy collagen fibers on it. The body will scar around it, but this is unhealthy scar tissue, not normal tissue remodeling. With a biologic-coated synthetic material, the body will heal differently, with healthy collagen formation and better integration of the hernia repair. If [the hybrid] is going to be more expensive than current prosthetic meshes, I would use it in clean settings with high-risk patients—obese patients, smokers, patients with diabetes, and so on. I also would use it in clean-contaminated cases where I would like to use a biologic but can’t because I can’t get the edges of the fascia together.

**Dr. Hope:** I would potentially use this in laparoscopic cases where I need some strength, where I may not need a true biologic mesh, where there may be high risk for wound infection, and in clean-contaminated cases. If it truly does help with in-growth of the polypropylene mesh, then it may have a role in all cases.

**Dr. El-Hayek:** Ultimately, the black box [indication] for this is in a hernia repair during an operation for something else. For example, if you see an incidental hernia during a potentially contaminated case, it may be beneficial to use a hybrid mesh. Also, some patients have allergies to foreign materials and you want to limit the amount of material you place in them. Those are the key potential advantages we may see in the future for a hybrid mesh.

**Dr. Bittner:** I see a role for Zenapro in primarily clean-contaminated or potentially contaminated cases via open technique in abdominal wall repair, and in laparoscopic repair for ventral or incisional hernia and/or parastomal hernia. There also may be a future for it in the repair of paraesophageal hernias at the hiatus, although there is no data on that yet. So, largely anywhere you would use a biologic, and I would expect better outcomes because of the longer-term synthetic.

7. **Would Zenapro replace what you are currently using? Why?**

**Dr. Yoo:** Again, if the price is right it would replace some prosthetic meshes. If the price is not right it would fall into my armamentarium with pure biologic meshes, perhaps preferentially, but it would not replace them all together. I still use Biodesign for all hiatal hernia repairs for conformation and because I don’t want the prosthetic mesh to hang around and cause complications. I also use Biodesign when I do a Sugarbaker technique. So I think there will still be a role for pure biologic meshes, but can we decrease their use with Zenapro? That answer is definitely yes.

**Dr. Hope:** I don’t think it will replace anything in particular that I’m currently using. It won’t eliminate biologic mesh because in the cases where I use a biologic mesh I may not want a synthetic in there. In cases where I use a pure synthetic mesh, I’m not 100% sure what benefit the biologic aspect would add. But I do think it may have a niche in certain cases where you want the best of both worlds—where you’re worried about infection but you also want more strength than the biologic will provide.
**Dr. El-Hayek:** Zenapro could potentially replace what I am currently using, depending on the clinical scenario. It will always come down to the indication. I don’t believe there will ever be one standard mesh for all clinical scenarios. Rather, Zenapro will be another tool in the toolbox and a nice addition to the hernia space. It will give surgeons another option in situations where it would be better to use a hybrid rather than a purely synthetic or purely biologic material.

**Dr. Bittner:** I would essentially use Zenapro as a replacement for biologic grafts in all but the most extreme cases. I don’t know that it would replace my use of non–barrier-coated synthetic graft. At this point, I have used Zenapro in clean laparoscopic ventral incision repair and clean open ventral incision repair in the retrorectus preperitoneal space.

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### References


### Discussion Results

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<tr>
<th></th>
<th>Dr. Yoo</th>
<th>Dr. Hope</th>
<th>Dr. El-Hayek</th>
<th>Dr. Bittner</th>
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Z= Would strongly consider use of Zenapro
Z or CP= Would consider Zenapro or Current Product