REVIEW ARTICLE

A Panoramic Review on Meshplasty for Hernia Correction-A Gold Standard Treatment Approach

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Abstract

Meshplasty is a medical term used for a surgical intervention involving a biomedical device called 'surgical mesh' for correcting a bulging organ or tissue in the peritoneal cavity or any other gap inside or outside the body, scientifically termed as 'hernia.' It is considered as a gold-standard treatment approach to the management of hernias. Surgical mesh made up of various materials like synthetic polymers or biomolecules is used for correction of hernia using surgical methods like inlay, onlay or underlay, depending upon the way of placing mesh. This review article also describes the merits and demerits of traditional and advanced surgical methods ranging from open surgery to laparoscopic and robot-assisted surgery. A systematic literature review in books, magazines and online databases like MedScape, PubMed, Science Direct, Google Scholar, Scilit, and researchGate was performed to collect the relevant data on 'hernia meshplasty'. This review article gives an enhanced spectrum of information on various types of hernias and various surgical methods used to correct these protrusions. The article also provides information about the various types of mesh used in performing the meshplasty, methods of mesh placement, surgery types and post-surgical complications are also described.

Keywords: Meshplasty, Hernia, Herniotomy, Hernioplasty, Herniorrhaphy, Mesh.
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Introduction

The word "HERNIA" is a Greek term meaning offshoot, a budding or bulge. In contrast, Latin means "rupture or tear"[1,2] and can be defined best as an abnormal protrusion of body organs through normal openings in the body wall. The protrusion can be internal or external and is named an internal or external hernia. Based on the involved body organ and location of hernia, it is classified as femoral, umbilical, lumbar, incisional, epigastric and hiatal hernia are other types of hernia. Inguinal hernia is the most common one. Ventral hernias occur through midline or lateral abdominal wall defects, including epigastric, umbilical, paraumbilical, incisional, and rare Spigelian hernias.[3,4] Figure 1 shows various types of hernias occurring in human beings.

Primary stage hernia can be reduced but as the size grows it starts causing discomfort, pain and become non reducible where surgery is the only option. Surgery is also prescribed to avoid future discomforts and complications even if the patient does not show any such major discomforts. Physical examination is employed to detect external hernias whereas routine ultrasound techniques are prescribed in case of internal hernias.[5]

Due to lack of any conservative or alternate treatment method, surgery is only option for all the types of hernias. Hernia surgeries are decided based on the type of hernias and complications the patient is suffering. Table 1 shows various methods of hernia correction surgeries.

Meshplasty or Hernioplasty or Hernia Mesh Surgery[8]

This procedure includes the correction of an organ protruding through a weak spot in the surrounding muscle or tissue, where surgeons use a surgical mesh made of biological or synthetic materials to cover the gap. Sutures or staples are then used to attach this medical device. The muscle wall is then strengthened due to the growth of the tissue, then grows into the mesh.

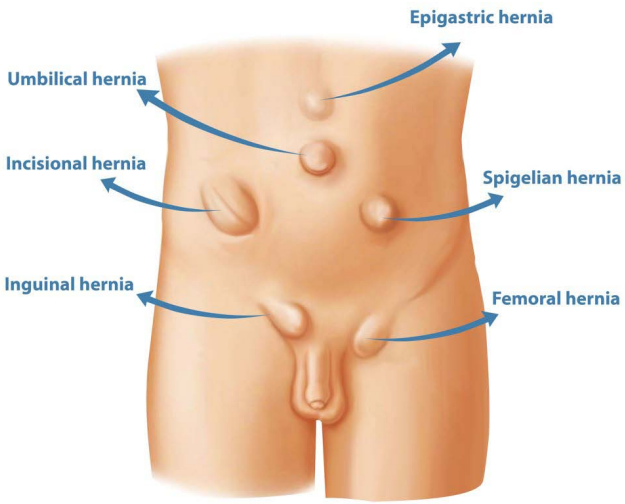

Figure 1: Various types of hernias

Table 1: Types of Hernia repair surgeries[6,7]

Herniorrhaphy	*Herniotomy*	*Hernioplasty*
Herniorrhaphy is chosen in cases of inguinal hernia where the size of the hernia is small and healthy muscle tissue is present around the hernia opening. Herniorrhaphy is the oldest type of hernia surgery and is still being used. It involves a surgeon making a long incision directly over the hernia and then using surgical tools to open the cut enough to access it. Tissues or displaced organ are then returned to their original location, and the hernia sac is removed.	Herniotomy is mostly performed for inguinal hernia in children. This surgery is performed under general anesthesia and takes about 45 to 60 minutes. Through a small incision in the inguinal region hernia sac is identified and the contents of sac are replaced in the abdominal cavity. The hernia sac is tied and excised. The child returns to his normal routine within a week after surgery.	Hernioplasty is the choice of surgery for large, complicated hernias where adjacent muscle tissue is weak. After correcting the defect of the hernia opening it is strengthened by putting a mesh.

Table 2: Various mesh types[11-15]

Mesh type	*Characteristics*
Absorbable	Degrades over time and absorbed by the body. As per USFDA, "As the material degrades, new tissue growth is intended to provide strength to the repair."
Nonabsorbable	Since it remains in the body so it offers long-lasting reinforcement to the surgical repair area.
Hybrid	This mesh comprises both layers of biological derivatives and synthetic polymers combining the strength of synthetics and benefits of animal-derived tissues like controlled inflammation, high tissue growth and reduced bacterial infection rates. Unfortunately, it will not succeed as desired by manufacturers as people reported adverse events from the use of hybrid mesh which raised a review concern to such types of mesh.
Animal-derived	These meshes are made up of biological tissue generally, the skin or intestines of cows or pigs are commonly used to manufacture. Recent studies reported high infection and recurrence rates compared to synthetic mesh.
Synthetic	Most commonly, high tensile strength offering materials like polypropylene, polyester and ePTFE are employed for the manufacturing of hernia mesh. Recent studies reported changes in the chemical properties of mesh upon implantation during hernia surgery. Some hernia repair techniques can place hernia mesh in contact with the intestines, causing them to stick to each other, potentially resulting in severe complications. To reduce the instances of adhesion, manufacturers began coating some types of polypropylene hernia mesh with cellulose, collagen, or absorbable fatty acids.

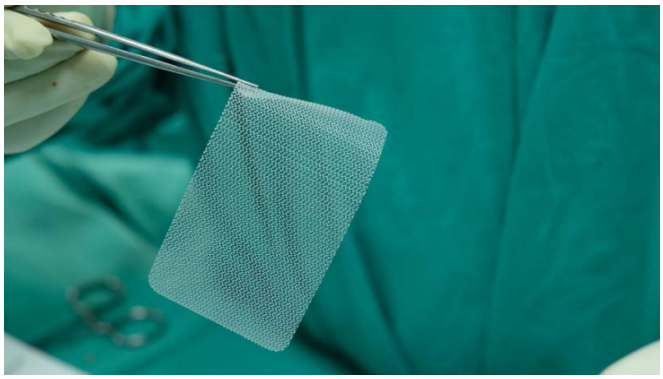

Figure 2: A typical surgical mesh

What is hernia mesh?[9,10]

A "mesh" in medical terminology is a flat sheet made up of prosthetic material and is used to "cover" or "patch" a hernia. A 'Hernia mesh or Surgical mesh' is a medical device implanted into the abdomen and upper stomach of the patient undergoing hernia surgery to provide strength and support to the weakened tissues. A well-implanted surgical mesh can prevent the reoccurrences of hernias. Surgical meshes are also employed for the closure of an opening from where a hernia protrudes within a damaged muscle. Figure 2 shows a typical mesh.

Hernia correction surgery is required every year for thousands of people throughout the globe and most of the surgeries ended with implantation of 'hernia mesh. However, the increased rate of using surgical mesh implants is also posing threats and challenges to patients as some of the improper implants, defective implants, and immune-compromising hernia mesh implants can cause life-threatening serious complications and to prevent the worsening of situation failed mesh must be removed that further add to the waste of both money and time.

Several factors that help a Surgeon to select the type of mesh to be used for hernia correction include the patient's age, the location, type and severity of hernia, overall health status and risk factors for recurrence. The rate of success after hernia mesh implants is directly proportional to the proper placement of appropriately chosen optimum-sized hernia mesh. The basic differences between various types of 'hernia mesh' are given below in Tables 2, 3 shows the leading manufacturers of various hernia meshes around the globe.

Surgical techniques used to repair hernias with mesh[17-21]

Based on the location of placement of mesh, the surgeries can be classified as follows:

- *Intraperitoneal or Onlay mesh placement:* Here, the mesh is placed overlying the defect (opening) made by the

Table 3: Major players in Hernia Mesh manufacturing[16]

Company	*Brand name*
LifeCell Corporation	Alloderm Select, Strattice
Ethicon	FlexHD Structural, Physiomesh, Proceed, Prolene, Ultrapro, Ultrapro Advanced, Vicryl, XCM Biologic
Gore Medical	Mycromesh, Synecor, Bio-A, Dual mesh, Gore-Tex Soft Tissue Patch,
Bard/ Davol	MK Patch, OnFlex, PerFix Plug, Composix, Dulex, Kugel, Phasix Mesh, IP Composite, Ventralex, 3DMax
B. Braun	Premilene, Omyra, Optilene
Atrium	C-QUR, Vitamesh, Proloop, Prolite, Prolite Ultra
Medtronic	Symbotex, Versatex, Parietex, Permacol, ProGrip,
TELA Bio	OviTex

hernia and sutures are used to close the defect. These kinds of surgery provide strength to the repair performed and the abdominal wall. The technique is quite easy and can be performed for both small and large hernias but is associated with some disadvantages, like a high level of suturing is required to secure the mesh around and onto the fascia surface. Also, there are chances of reoccurrence and seroma formation.

- *Extraperitoneal or Inlay mesh placement:* This technique involves placing the mesh between the edges of the fascia where the defect made by the hernia is. Inlay placement does not actually close the gap. Rather, the mesh is fixed with sutures to the edges of the gap to bridge the defect. This technique is also relatively easy to perform. For dealing with small gaps made by hernias and since minimal mesh is used, the chances of recurrence, seroma formation and infection are less, but chances increase as the defect size increases.
- *Transabdominal Preperitoneal or Underlay mesh placement* involves placing the mesh on the underside of the gap or inside the fascia. Because of this technique, it is also referred to as the inside-out technique for hernia repair. The sutures are circumferentially and evenly used to fix the mesh and close the gap. This method helps improve the tension that results in the mechanical disadvantage of the inlay and onlay techniques. Because the pressure is stabilized, there is less risk of hernia recurrence. Because of its placement, too, there is less risk of seroma formation and infection. However, this technique is not easy, which constitutes as disadvantage of because it is very difficult to determine how much space there is for the mesh and it is difficult to suture or keep the mesh in place because it is done from under the fascia.

There are several factors that assist in deciding which technique to follow for surgery. The factors are given below:

- Size of the hernia and gap made by the hernia;
- Underlying conditions of the patient;
- Overall medical status of the patient, and
- Surgeon preference.

Various types of Surgeries performed to place mesh[22-26]

Laparoscopic Surgery

It's a gold standard surgical approach in hernia surgeries and a minimally invasive technique performed under general anesthesia where a surgeon makes small incisions and, using a laparoscope (a telescope-like tool equipped with a camera and with or without a mesh) conducts the surgery to repair or cover the defect. This technique offers less pain and suffering, small incisions and quick recovery. Figure 3 depicts the surgical intervention using Laproscope.

The technique is typically used to repair inguinal, umbilical, ventral or incisional types of hernias. The chances of recurrence after laparoscopic procedures are less than 0.3%.

Open Repair Surgery

In this technique, the surgeon performs the operation under local anesthesia with sedation. Here, surgeons incision over the hernia, retract the bulging part to its original place, and affixes the mesh to nearby healthy tissues. Since large incisions are made and more muscles are injured during this method so there are increased chances of blood loss, pain, infection and increased recovery time as compared to the laparoscopic technique. The technique is relatively cheaper than laparoscopic methods. Figure 4 shows an open hernia mesh surgery.

Robotic-Assisted Surgery

This is the most advanced form of surgery involving a laparoscope operated or equipped with a robotic instrument. Figure 5 shows surgeons operating robots during surgery. Here, the surgeon performs surgeries with a more comprehensive 3D view of the defective areas using a console in the operation theatre, preserving the surrounding non-affected body areas. Also, the equipment is too miniature to damage the surrounding organs and is used precisely using software-assisted tools. Robotic technique prevents tissue damage and blood loss and offers nominal pain levels. These

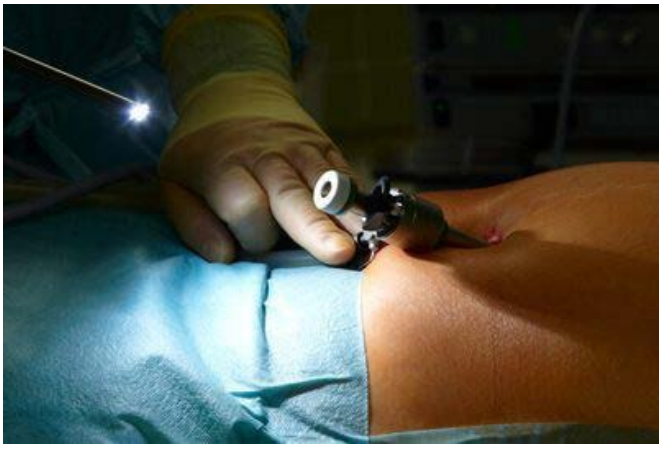

Figure 3: Hernia repair surgery using laparoscopy

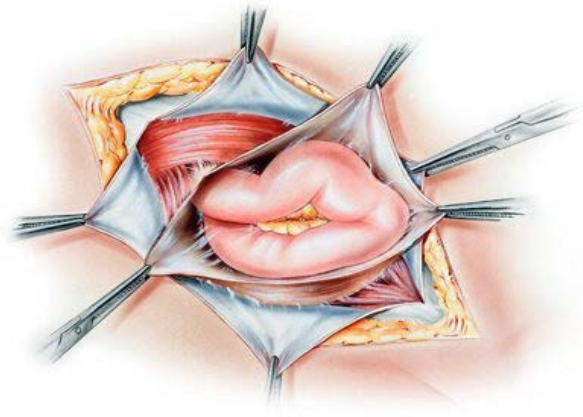

Figure 4: Open hernia mesh repair

Figure 5: Surgeon performing robotic surgery

features of robotic surgeries are advantageous over other methods of surgery.

Post-surgery complications

- Bowel obstruction
- Hernia recurrence
- Infection
- Mesh adhering to internal organs
- Reactions to the mesh
- Severe pain

Mesh surgery failure can also cause nausea, vomiting, fever, pain, swelling, bruising and difficulty urinating or passing stool.

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