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Review Article

Hernia Mesh: Understanding the Properties and Selection of Materials for Hernia Repair

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ABSTRACT

Hernia repair remains one of the most common procedures in general surgery, and mesh reinforcement has become the standard of care to reduce recurrence rates. A wide variety of mesh types and materials have been developed to address specific surgical needs and patient risk factors. This review provides an updated overview of synthetic and biological meshes, highlighting their properties, advantages, and limitations. Non-absorbable synthetic meshes, such as polypropylene and polyester, offer durable strength but may induce significant inflammatory responses, while ePTFE minimises adhesions at the cost of poor tissue integration. Absorbable synthetic meshes provide temporary support in contaminated fields but risk early degradation. Biological meshes derived from human or animal tissue offer high biocompatibility and suitability for infected settings but are expensive and mechanically weaker. Composite meshes combine different materials to balance tissue integration with anti-adhesive barriers for safe intraperitoneal use. Key factors in mesh selection include placement location (extra- vs intra-peritoneal), wound condition (clean vs contaminated), desired properties (lightweight, macroporous, monofilament structure), and appropriate sizing with sufficient overlap to prevent recurrence. Understanding these considerations is essential for optimising patient outcomes, reducing complications such as chronic pain or infection, and ensuring long-term hernia repair durability.

Keywords: Hernia, Mesh, Mesh selection

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Introduction

Hernia repair is among the most common surgical procedures performed in general surgery.[1] Among the types of hernias, inguinal hernia repair is the most frequent, followed by ventral and incisional hernias. Historically, treatment primarily involved direct suture repair of the abdominal wall using primary tissue approximation techniques that relied on the patient's own tissues. However, these methods were associated with unacceptably high recurrence rates, often exceeding 10%.[2] A paradigm shift occurred in the mid-20th century with the introduction of reinforcing materials, known as "hernia mesh" which revolutionised hernia surgery and led to the development of tension-free mesh repairs.3 The first hernia meshes, known as silver filigrees, were made from silver wire and used in the late 19th and early 20th centuries. However, they were later abandoned due to issues like stiffness, toxicity, and adverse tissue reactions.[4] Over time, improved synthetic materials were developed, culminating in the use of polypropylene and polyester meshes that remain the standard today. These innovations enabled the adoption of the Lichtenstein technique in the 1980s–now a cornerstone of inguinal hernia repair–which uses a flat sheet of polypropylene mesh laid without tension over the inguinal floor, and has markedly reduced recurrence rates to below 2% in experienced hands.[5] Today, mesh-based repair is the gold standard for hernia surgery–applied in both open and laparoscopic approaches–and is routinely used for inguinal, ventral, and incisional hernia repairs.[5,6]

Despite the success of mesh repair in reducing recurrences, the increased use of prosthetic materials has introduced new challenges. Although numerous publications have proposed the concept of the "ideal mesh," no currently available material meets this definition.[7,8] At present, there is no surgical technique or mesh type capable of achieving a 0% recurrence rate. Furthermore, mesh-related complications such as chronic pain, infection, adhesion formation, bowel obstruction, and mesh migration or erosion remain significant concerns.[9-11] These complications have prompted substantial research and innovation in mesh design, leading to the development of a wide array of synthetic, biological, biosynthetic, and composite meshes.[12-14] Surgeons are therefore faced with the complex task of selecting the most appropriate mesh from hundreds of commercially available options, each with distinct mechanical properties, pore sizes, degradation profiles, and tissue integration characteristics.

In this context, it is critical for surgeons to understand the biomechanical and biological properties of various mesh types to optimize outcomes and minimize complications. This review aims to provide a comprehensive overview of the properties of hernia meshes and present a practical framework for mesh selection based on clinical scenarios, including wound classification, hernia type, and surgical approach. The ultimate goal is to support evidence-based, patient-specific decision-making in modern hernia repair.

Key Properties of Hernia Mesh

Choosing the right mesh requires a comprehensive understanding of its physical characteristics and biological interactions with host tissues. These characteristics directly influence surgical outcomes, including mesh integration, risk of infection, postoperative pain, and recurrence rates.[7,12,15]

1. Mesh Material

Due to the characteristics of the mesh material, hernia meshes can be broadly classified into two main categories based on their origin: synthetic meshes and biological meshes. Each category contains several subtypes defined by their material composition, absorption profile, and functional design.16 Understanding these categories and subtypes is essential for appropriate mesh selection in different clinical scenarios.

1.1 Synthetic mesh

Synthetic meshes are manufactured from man-made polymers and remain the most widely used type in hernia repair.[17] Currently used synthetic polymers include polypropylene (PP), polyester (PET), expanded polytetrafluoroethylene (ePTFE), and polyvinylidene fluoride (PVDF). PP (typically monofilament, macroporous) offers durable reinforcement with favorable infection resistance; PET (often multifilament) is compliant but more prone to hydrolysis and infection in contaminated fields;[18] ePTFE provides a smooth, microporous barrier suitable for intraperitoneal contact but integrates poorly with the abdominal wall;[19] and PVDF has promising biostability and handling characteristics, though with comparatively less long-term evidence.[20] They can be further classified into:

- **Non-absorbable synthetic mesh** – Made from permanent materials such as polypropylene (PP), polyester (PET), and expanded polytetrafluoroethylene (ePTFE). These meshes provide durable reinforcement but remain permanently in the body.15
- **Absorbable synthetic mesh** – Made from polymers such as polyglactin or polyglycolic acid, these meshes are gradually resorbed by the body, providing temporary support during healing.
- **Composite mesh** – Combines a structural mesh layer (often synthetic) with an anti-adhesive barrier (e.g., collagen, oxidized cellulose, ePTFE, titanium coating, silicone layer) to reduce visceral adhesions in intraperitoneal placements.
- **Anatomical mesh** – pre-shaped or three-dimensional (3D/4D) designs intended to conform to specific anatomical structures, such as the myopectineal orifice in inguinal hernia repairs.

1.2 Biological Meshes

Biological meshes are derived from decellularized human (allograft) or animal (xenograft) tissues, such as dermis or pericardium. They act as extracellular matrix scaffolds to promote tissue regeneration. Subtypes include:[21,22]

- **Allografts** – Derived from donated human tissue.
- **Xenografts** – Derived from animal sources, most commonly porcine dermis or bovine pericardium.

Biological meshes may be cross-linked (to prolong durability) or non-cross-linked (to allow faster integration and absorption).

Synthetic and biological meshes differ substantially in their material properties, clinical applications, and long-term outcomes. Synthetic meshes, particularly non-absorbable types such as polypropylene and polyester, offer permanent reinforcement with excellent long-term durability and low recurrence rates in clean surgical fields. However, they are associated with a higher risk of chronic pain, foreign body sensation, and mesh infection, especially in contaminated or infected environments. In contrast, biological meshes, derived from decellularized human or animal tissues, are biocompatible and promote host tissue integration while reducing the risk of infection and erosion. Their main disadvantages include high cost, variable long-term durability, and a higher recurrence rate compared to permanent synthetic meshes in clean settings.

To bridge the gap between these two extremes, biosynthetic meshes were developed as an intermediate option. Constructed from slowly absorbable synthetic polymers (e.g., poly-4-hydroxybutyrate, polyglycolic acid blends), these meshes are designed to mimic the biological response of natural tissue scaffolds while offering predictable degradation kinetics, reduced infection risk, and lower cost compared to biological meshes. This makes them an attractive alternative in complex abdominal wall reconstructions, especially in patients at higher risk of infection where permanent mesh may be unsuitable, but biological mesh is not feasible due to cost constraints. The summary of mesh material in Table 1.[6,23,24]

Clinical Considerations

- Synthetic non-absorbable meshes (e.g., polypropylene, polyester) are preferred in clean, elective hernia repairs because they provide permanent support with low recurrence rates.6
- Absorbable synthetic meshes are generally reserved for contaminated or infected surgical fields, where permanent meshes are contraindicated.
- Composite meshes are the mesh of choice for intraperitoneal placement (e.g., laparoscopic ventral hernia repair) due to their anti-adhesive barriers that reduce the risk of bowel adhesion and erosion.6
- Anatomical meshes may improve fit and

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reduce operative time in inguinal hernia repair but are associated with higher cost.[6]

- Biological meshes are best suited for complex reconstructions in contaminated fields, immunocompromised patients, or cases with prior mesh infection.[6,25]

- Biosynthetic meshes can be considered in situations requiring temporary reinforcement with predictable degradation, particularly in high-risk patients where biological mesh cost is prohibitive.[25,26]

Table 1 Types of Hernia Mesh and Examples

Main Category	Subtype	Description	Example
Synthetic Mesh	Non-absorbable synthetic mesh	Permanent polymer mesh for long-term reinforcement	Polypropylene (PP), Polyester (PET), ePTFE
	Absorbable synthetic mesh	Polyglactin, Polyglycolic acid	Vicryl® Mesh, Dexon® Mesh
	Composite mesh	Structural mesh with anti-adhesive barrier for intraperitoneal use	Ventralight™ ST (PP + barrier), Parietex™ Composite (PET + collagen), TiMesh® (titanium-coated PP), DualMesh® Plus (ePTFE with silicone layer)
	Anatomical mesh	Pre-shaped or 3D/4D mesh to fit specific anatomy	3DMax™ Light Mesh, ProGrip™ Anatomical Mesh
	Biosynthetic mesh	Slowly absorbable synthetic mesh mimicking biological properties	Phasix™ (P4HB), Bio-A®
Biological Mesh	Allograft	Human-derived decellularized tissue	Alloderm®
	Xenograft	Animal-derived decellularized tissue	Strattice™ (porcine dermis), Peri-Guard® (bovine pericardium)

2. Filament structure

The filament structure of a hernia mesh refers to the configuration of the polymer strands used in its construction. This structural characteristic plays a critical role in determining the mesh's handling properties, tissue integration, and susceptibility to infection. Filaments can be broadly classified into monofilament and multifilament designs.

• **Monofilament:** Comprised of single, continuous, and smooth filaments. The smooth surface limits bacterial adherence, and the larger inter-filament spaces allow immune cells such as macrophages and neutrophils to reach and clear potential contaminants. Monofilament meshes are generally associated with lower infection rates and are often preferred in potentially contaminated surgical fields.[27] They also tend to have higher stiffness compared with multifilament meshes of the same weight, but advances in knitting technology have improved their flexibility.[28]

- **Multifilament:** Constructed from multiple filaments braided, twisted, or woven together to form each strand. This design can improve mesh pliability and conformability, making it easier to handle and position, particularly in laparoscopic procedures. However, the small interstices between individual filaments can act as niches for bacterial colonisation, potentially shielding pathogens from host immune defences. As a result, multifilament meshes carry a higher risk of infection in contaminated or dirty surgical wounds.[28]

Clinical Considerations:

Selection between monofilament and multifilament designs should be guided by the balance between handling characteristics and infection risk. Monofilament meshes are generally preferred in contaminated fields, whereas multifilament meshes may be advantageous in elective, clean cases where superior pliability is desired.

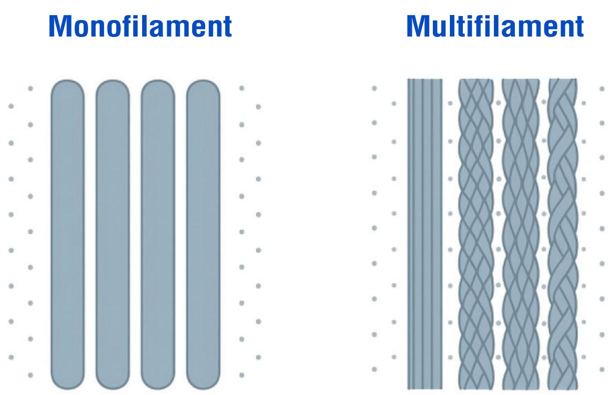

Figure 1 Schematic illustration comparing monofilament and multifilament mesh structures. The monofilament mesh (left) consists of single, smooth polymer filaments with larger pore spaces, which limit bacterial adherence and facilitate immune cell penetration. The multifilament mesh (right) is composed of multiple braided or twisted fibers with small interstices, providing greater flexibility but creating potential niches for bacterial colonization.

Table 2. Examples of Monofilament vs. Multifilament Hernia Mesh

Filament Structure	Mesh Category	Material Type	Example Commercial Products
Monofilament	Synthetic, non-absorbable	Polypropylene (PP)	Prolene® Mesh
	Synthetic, non-absorbable	Polyvinylidene fluoride (PVDF)	DynaMesh®-IPOM
	Synthetic, biosynthetic	Poly-4-hydroxybutyrate (P4HB)	Phasix™ Mesh
	Synthetic, composite	Titanium-coated polypropylene	TiMesh®
	Synthetic, composite	ePTFE with silicone layer	Gore® DualMesh® Plus
Multifilament	Synthetic, non-absorbable	Polyester (PET)	Parietex® Mesh
	Synthetic, composite	Polyester + collagen barrier	Parietex™ Composite
	Synthetic, non-absorbable	Polyester	Bard™ Soft Mesh
	Synthetic, anatomical	Polyester with polylactic acid microgrips	Parietene™ ProGrip™
	Synthetic, non-absorbable	Polypropylene (braided)	Surgipro™ Mesh

3. Textile Pattern

The textile pattern of a hernia mesh describes how its filaments are arranged and bound together. These structural characteristic influences mesh elasticity, porosity, handling, and biological response. Two main patterns are commonly used: knitted and woven.

- **Knitted Mesh:** Knitted meshes are produced by looping filaments together in an interconnected pattern, which imparts superior elasticity and conformability. These properties allow the mesh to adapt to dynamic anatomical regions such as the abdominal wall, where continuous movement occurs during respiration, coughing, and daily activities. The higher porosity of knitted meshes facilitates rapid tissue integration and reduces the risk of encapsulation. However, knitted meshes may be more prone to fraying when trimmed.

- **Woven Mesh:** Woven meshes are constructed by interlacing filaments in a fixed, orthogonal pattern, producing greater dimensional stability and high tensile strength. They are typically stiffer and have lower porosity, which may reduce flexibility and increase the risk of encapsulation. Nevertheless, their rigid structure makes them advantageous in scenarios requiring precise trimming, as they fray less than knitted designs. Woven meshes are also beneficial in specific reconstructions where minimal mesh deformation is desirable.

Clinical Considerations:

Knitted meshes are preferred for large, dynamic areas of repair (e.g, abdominal wall, inguinal hernia) due to their flexibility and high porosity.[28,29]

Woven meshes may be considered when maximal strength and shape stability are required, such as in small, well-defined defects or when precise intraoperative trimming is necessary.[18,29]

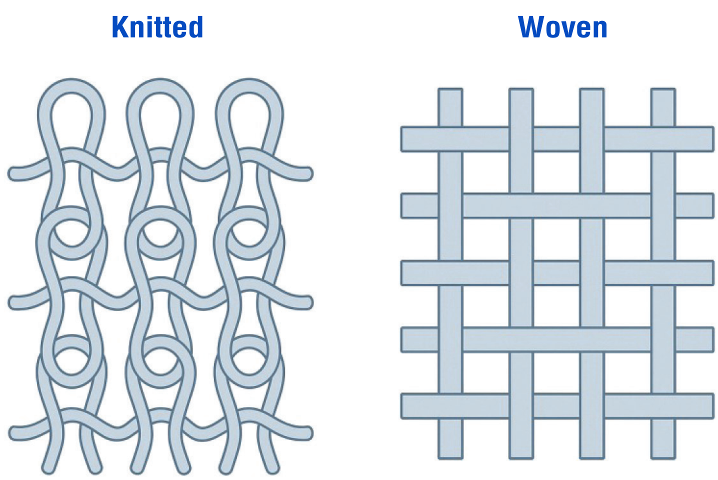

Figure 2 Schematic illustration comparing knitted and woven mesh structures. The knitted mesh (left) is composed of interloop filaments, providing high elasticity, flexibility, and large pores that enhance tissue integration. The woven mesh (right) consists of interlaced filaments in a fixed.

4. Mesh weight

Mesh weight refers to the amount of polymer per unit area, which is closely linked to pore size, filament thickness, and the overall inflammatory response. Despite its clinical relevance, there is no universally accepted definition for mesh weight classification in international guidelines. Historically, meshes were simply categorised as heavyweight or lightweight.[3,27,30,31]

- Heavyweight meshes offer high tensile strength but often induce a more pronounced foreign body reaction, leading to greater fibrosis, stiffness, and a higher risk of chronic pain.
- Lightweight meshes contain less polymer, have larger pores, and are designed to improve flexibility and biocompatibility while maintaining adequate strength for most hernia repairs.

Advances in mesh engineering have prompted the introduction of additional categories, such as medium-weight and ultra-lightweight, to provide a more tailored balance between mechanical reinforcement and physiological compatibility. These newer classifications are not yet standardised across manufacturers, but are increasingly adopted in research and product descriptions.

Proposed classification in contemporary literature:[32]

- Heavyweight (> 90 g/m²) – Thick filaments, small pores; maximal strength but higher inflammatory response.
- Medium-weight (50–90 g/m²) – Intermediate balance between strength and flexibility.
- Lightweight (35–50 g/m²) – Thinner filaments, large pores (> 1 mm); reduced foreign body reaction and stiffness.
- Ultra-lightweight (< 35 g/m²) – Minimal polymer content; designed for maximal flexibility and comfort while retaining sufficient strength.

Guideline Perspective

International guidelines generally favour lightweight mesh in open inguinal hernia repair to minimise the foreign body reaction and reduce the risk of chronic postoperative pain.[6]

However, in laparoscopic inguinal hernia repairs (TEP/TAPP), multiple RCTs and meta-analyses have demonstrated no significant difference between lightweight, and heavyweight meshes regarding recurrence, chronic pain, or complication rates. This is likely due to reduced mesh fixation area, less tissue dissection, and a different biomechanical environment in laparoscopic repairs.[6]

Clinical Considerations:

- Lightweight mesh is generally recommended for routine inguinal repairs, especially in open approaches, for better patient comfort and reduced chronic pain.
- Mesh weight selection in laparoscopic repair should be guided by surgeon experience and handling preference rather than weight alone.
- Heavyweight meshes remain relevant for complex, recurrent, or high-tension hernias where maximum reinforcement is needed.

5. Pore Size

Pore size is a key determinant of hernia mesh biocompatibility, tissue integration, and the host inflammatory response.[3,27,30]

- Macroporous mesh (>75 μm)

Macroporous meshes allow infiltration of macrophages, fibroblasts, and neovascular structures, promoting collagen deposition and stable mesh incorporation. The larger pore size also helps prevent granuloma bridging, a process in which foreign body granulomas surrounding individual filaments merge to form a rigid scar plate, thereby reducing mesh flexibility. Evidence indicates that pores exceeding 1 mm (1,000 μm) provide the most effective protection against granuloma bridging and enhance long-term mesh pliability and host integration.

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- Microporous mesh (<10 μm)

Microporous meshes, such as expanded polytetrafluoroethylene (ePTFE), carry a higher risk of infection, particularly in contaminated surgical fields. This is because bacteria, typically around 1 μm in size, can penetrate the pores, while immune cells are too large to follow, resulting in ineffective bacterial clearance. Additionally, microporous structures tend to integrate less effectively with surrounding tissue compared to macroporous designs.

While the conventional definition of macroporosity is a pore size greater than 75 μm, current evidence suggests that pores larger than 1 mm offer optimal cellular infiltration, tissue incorporation, and reduced granuloma bridging.

6. Mechanical properties

6.1 Tensile Strength:

Early generations of hernia mesh were designed with tensile strengths far exceeding physiological requirements. Studies indicate that the maximum intra-abdominal pressure–such as during coughing–can reach approximately 170 mmHg, which translates to a force of only 16–32 N/cm on the abdominal wall. Even lightweight meshes surpass this threshold by a considerable margin. Therefore, excessive tensile strength is no longer considered a primary selection criterion for modern mesh design.[18]

6.2 Elasticity:

Elasticity is critical for maintaining abdominal wall function. Optimal elasticity should approximate that of the native abdominal wall (20%–35%)[19], allowing natural movement and expansion during respiration, coughing, and physical activity. Meshes that are too stiff can cause discomfort and limit mobility, whereas overly elastic meshes may lose structural support, leading to bulging or recurrence.[32,33]

6.3 Anisotropy:

The anisotropic nature of most meshes arises in part from their textile structure–whether knitted or woven–but is also influenced by filament orientation and mesh design. While textile pattern affects elasticity and handling, anisotropy specifically concerns directional mechanical strength, which guides proper mesh orientation during implantation.[32,33]

7. In Vivo Performance – Mesh Shrinkage

Mesh shrinkage is considered an undesirable property, as it compromises the long-term stability and coverage of the repair. It results from the contraction of scar tissue that forms around the implant. Heavyweight, small-pored meshes are more prone to shrinkage due to the formation of a dense scar plate, which exerts greater contractile forces. The degree of shrinkage can be substantial, reaching over 30–50% in some mesh types, and is a major cause of recurrence as the mesh retracts from its fixation points. Different materials exhibit varying shrinkage rates; for example, polytetrafluoroethylene (PTFE) has been reported

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to shrink by up to 51%, whereas polypropylene (PP) demonstrates shrinkage of up to 25.4%.[8,12,34]

Principles of Mesh Selection[1,35]

There is no single "ideal" mesh for all situations. The selection should be based on a careful assessment of multiple factors:

1. Wound Condition:

Wound condition is an important consideration in mesh selection. In a clean surgical field, non-absorbable synthetic meshes are the standard choice. In contrast, in contaminated or infected fields, permanent synthetic meshes should be avoided. Instead, an absorbable synthetic mesh or a biological mesh is recommended, as these materials are more resistant to infection and help reduce the need for future mesh explanation.36

2. Placement Location:

Placement location refers to whether the mesh is positioned extra-peritoneally or intra-peritoneally. In extra-peritoneal placements, where the mesh is not in contact with the viscera, standard lightweight, macroporous synthetic meshes such as polypropylene (PP) or polyester (PET) are suitable for repairs like the Lichtenstein procedure. In contrast, intra-peritoneal placements involve direct contact with the viscera, making it crucial to use a mesh with an anti-adhesive barrier, such as a composite mesh or expanded polytetrafluoroethylene (ePTFE), to prevent the serious complication of bowel adhesion.[37]

3. Desired Properties:

Desired properties generally favour a lightweight, macroporous, monofilament mesh to minimise long-term complications such as chronic pain, inflammation, and foreign body sensation.6

4. Size and Shape:

Size and shape are also critical considerations. The mesh must be large enough to overlap the hernia defect by at least 4–5 cm on all sides to account for mesh shrinkage and to prevent recurrence at the mesh edge.[38,39]

5. Elective or emergency hernia situation

Although the distinction between elective and emergency surgery traditionally influenced mesh selection, current practice emphasizes wound classification and risk of contamination as the primary factors.

In cases of incarcerated or irreducible hernia, the key determinant is whether contamination or bowel compromise is present. If the surgical field remains clean or clean-contaminated, mesh placement–particularly with lightweight or composite meshes–is considered safe and effective.

Therefore, mesh selection should be guided more by the degree of contamination rather than the urgency of the operation (elective vs. emergency).

Based on my own experience as a practising surgeon, I believe mesh selection must always be individualized, carefully considering patient-

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specific factors, placement location, wound contamination, the surgical approach (open versus laparoscopic), and available resources. For clean, open inguinal hernia repairs, I generally prefer a lightweight, macroporous polypropylene mesh because it offers adequate strength, good flexibility, a reduced risk of chronic pain, and cost-effectiveness. In the context of intraperitoneal placement, such as during a laparoscopic ventral hernia repair, my preference is for composite meshes equipped with an absorbable anti-adhesive barrier to minimize adhesion formation and bowel complications. I strongly advise against using permanent synthetic meshes in contaminated or infected fields due to the high risk of severe infection. In these cases, I opt for either absorbable synthetic meshes or biological meshes. Despite their higher cost, patient safety is the paramount consideration. Ultimately, mesh selection should be both evidence-based and guided by surgical experience to ensure the best possible outcomes and long-term quality of life for patients. The mesh selection algorithm is illustrated in Figure 3.

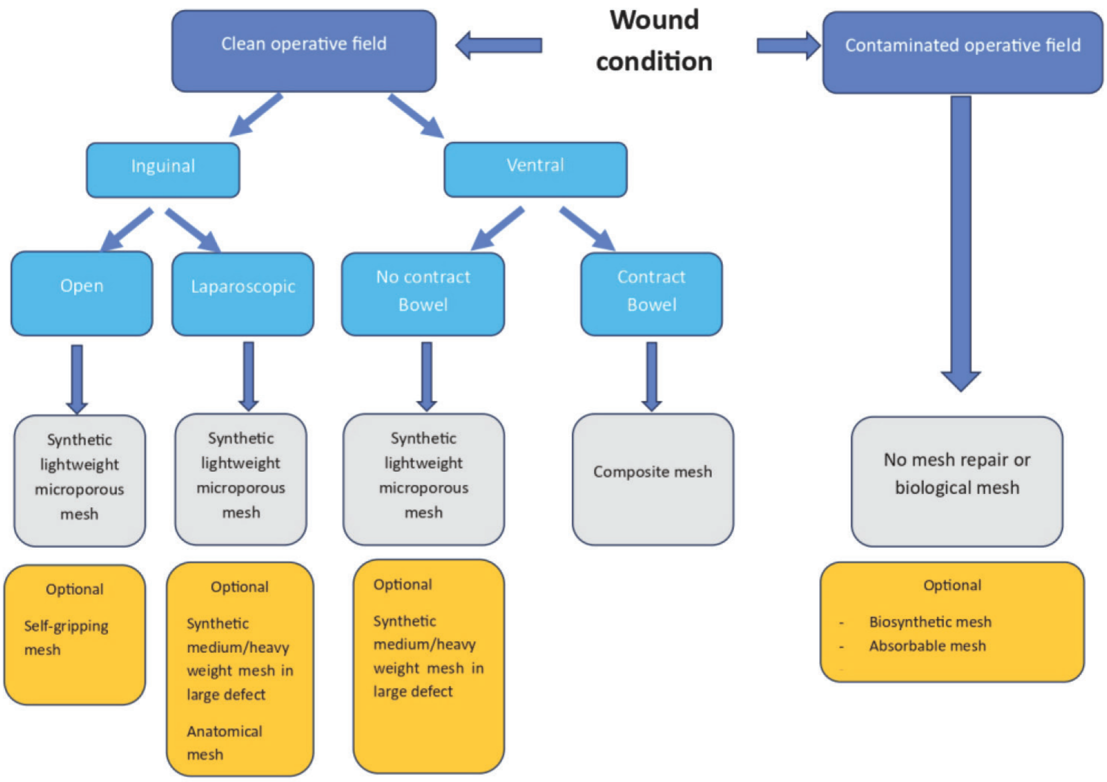

Figure 3 Flowchart for Mesh Selection Based on Operative Field and Hernia Type.

Conclusion

The development of hernia mesh has progressed significantly, moving from the initial heavyweight concept to the current preference for lightweight, large-pored materials that offer better outcomes regarding patient comfort and chronic inflammation. No single mesh is ideal for every clinical scenario. The selection process is a complex decision-making process that must balance the properties of the mesh (material, weight, pore size, mechanics) with the clinical context of the patient (type of hernia, placement location, wound condition). A thorough understanding of these factors is essential for surgeons to make an informed choice, minimize complications, and ultimately improve the long-term quality of life for their patients.

References

1. Köckerling F, Simons MP. Current Concepts of Inguinal Hernia Repair. Visc Med. 2018;34(2):145-50.
2. Grebić D, Havidić K. Historical review of surgical technique for operative treatment of inguinal hernia. Acta Med Hist Adriat. 2025;22(2):251-9.
3. Saiding Q, Chen Y, Wang J, Pereira CL, Sarmento B, Cui W, et al. Abdominal wall hernia repair: from prosthetic meshes to smart materials. Mater Today Bio. 2023;21:100691.
4. Salgaonkar H, Lomanto D. Mesh technology. Ann Laparosc Endosc Surg. 2017;2.
5. Amid PK. Lichtenstein tension-free hernioplasty: its inception, evolution, and principles. Hernia. 2004;8(1):1-7.
6. International guidelines for groin hernia management. Hernia. 2018;22(1):1-165.
7. Cobb WS, Burns JM, Peindl RD, Carbonell AM, Matthews BD, Kercher KW, et al. Textile analysis of heavy weight, mid-weight, and light weight polypropylene mesh in a porcine ventral hernia model. J Surg Res. 2006;136(1):1-7.
8. Klinge U, Klosterhalfen B, Conze J, Limberg W, Obolenski B, Öttinger A, et al. Modified mesh for hernia repair that is adapted to the physiology of the abdominal wall. Eur J Surg. 1998;164(12):951-60.
9. Alfieri S, Amid PK, Campanelli G, Izard G, Kehlet H, Wijsmuller AR, et al. International guidelines for prevention and management of post-operative chronic pain following inguinal hernia surgery. Hernia. 2011;15(3):239-49.
10. LeBlanc KA, Elieson MJ, Corder JM, 3rd. Enterotomy and mortality rates of laparoscopic incisional and ventral hernia repair: a review of the literature. JSLS. 2007;11(4):408-14.
11. Wu JF, Chen J, Hong F. Intestinal erosion caused by meshoma displacement: A case report. World J Gastrointest Surg. 2023;15(1):114-20.
12. Deeken CR, Lake SP. Mechanical properties of the abdominal wall and biomaterials utilized for hernia repair. J Mech Behav Biomed Mater. 2017;74:411-27.
13. Campanelli G, Catena F, Ansaloni L. Prosthetic abdominal wall hernia repair in emergency surgery: from polypropylene to biological meshes. World J Emerg Surg. 2008;3:33.
14. Sanders DL, Kingsnorth AN. Prosthetic mesh materials used in hernia surgery. Expert Rev Med Devices. 2012;9(2):159-79.
15. Klinge U, Klosterhalfen B. Mesh implants for hernia repair: an update. Expert Rev Med Devices. 2018;15(10):735-46.
16. Köckerling F, Sheen AJ, Berrevoet F, Campanelli G, Cuccurullo D, Fortelny R, et al. The reality of general surgery training and increased complexity of abdominal wall hernia surgery. Hernia. 2019;23(6):1081-91.
17. Gönüllü D, Köksoy FN. The Prosthetic Materials in Hernia Repair. J Acad Res Med. 2015;5(1):1-5.

18. Zhu L-M, Schuster P, Klinge U. Mesh implants: An overview of crucial mesh parameters. World J Gastrointerest Surg. 2015;7(10):226-236.
19. Brown CN, Finch JG. Which mesh for hernia repair? Ann R Coll Surg Engl. 2010;92(4):272-8.
20. Rodríguez M, Gómez-Gil V, Pérez-Köhler B, Pascual G, Bellón JM. Polymer Hernia Repair Materials: Adapting to Patient Needs and Surgical Techniques. Materials (Basel). 2021;14(11).
21. Trippoli S, Caccese E, Tulli G, Ipponi P, Marinai C, Messori A. Biological meshes for abdominal hernia: Lack of evidence-based recommendations for clinical use. Int J Surg. 2018;52:278-84.
22. Novitsky YW. Biology of biological meshes used in hernia repair. Surg Clin North Am. 2013;93(5):1211-5.
23. Sanders DL, Pawlak MM, Simons MP, Aufenacker T, Balla A, Berger C, et al. Midline incisional hernia guidelines: the European Hernia Society. Br J Surg. 2023;110(12):1732-68.
24. Henriksen N, Montgomery A, Kaufmann R, Berrevoet F, East B, Fischer J, et al. Guidelines for treatment of umbilical and epigastric hernias from the European Hernia Society and Americas Hernia Society. Br J Surg. 2020;107(3):171-90.
25. Köckerling F, Alam NN, Antoniou SA, Daniels IR, Famiglietti F, Fortelny RH, et al. What is the evidence for the use of biologic or biosynthetic meshes in abdominal wall reconstruction? Hernia. 2018;22(2):249-69.
26. Al-Bustami IS, Clements T, Ferguson D, Harmouch A, Olavarria OA, Holihan JL. Biosynthetic mesh in hernia repair: A systematic review and meta-analysis. Int J Abdom Wall Hernima Surg. 2024;7(2):55-66.
27. Bilsel Y, Abci I. The search for ideal hernia repair; mesh materials and types. Int J Surg. 2012;10(6):317-21.
28. Wang See C, Kim T, Zhu D. Hernia Mesh and Hernia Repair: A Review. Eng Regen. 2020;1:19-33.
29. Sanbhal N, Miao L, Xu R, Khatri A, Wang L. Physical structure and mechanical properties of knitted hernia mesh materials: A review. J Ind Text. 2018;48(1):333-60.
30. Deveci CD, Öberg S, Rosenberg J. Definition of Mesh Weight and Pore Size in Groin Hernia Repair: A Systematic Scoping Review of Randomised Controlled Trials. J Abdom Wall Surg. 2023;2:11179.
31. Krpata DM, Petro CC, Prabhu AS, Tastaldi L, Zolin S, Fafaj A, et al. Effect of Hernia Mesh Weights on Postoperative Patient-Related and Clinical Outcomes After Open Ventral Hernia Repair: A Randomized Clinical Trial. JAMA Surg. 2021;156(12):1085-92.
32. Özant A, Arslan K. Synthetic Meshes in Hernia Surgery. Cyprus J Med Sci. 2023.
33. Pott PP, Schwarz ML, Gundling R, Nowak K, Hohenberger P, Roessner ED. Mechanical properties of mesh materials used for hernia repair and soft tissue augmentation. PLoS ONE. 2012;7(10):e46978.
34. Klinge U, Klosterhalfen B, Müller M, Ottinger AP, Schumpelick V. Shrinking of polypropylene mesh in vivo: an experimental study in dogs. Eur J Surg. 1998;164(12):965-9.
35. Yewande A, Chamilka M, Michael S, Marielle M, Parag B. Mesh and plane selection: a summary of options and outcomes. Plast Aesthet Res. 2020;7:5.
36. Keric N, Campbell A. Meshing around: high-risk hernias and infected mesh. Trauma Surg Acute Care Open. 2024;9(Suppl 2):e001379.
37. Ellis R, Miller BT. Mesh Selection in Abdominal Wall Reconstruction: An Update on Biomaterials. Surg Clin North Am. 2023;103(5):1019-28.
38. Tansawet A, Rodsakan T, Kasetsermwiriya W, Lerdsirisopon S, Techapongsatorn S. The Myopectineal Orifice: A Study of Thai Cadavers. Front Surg. 2022;9:843344.
39. Howard R, Ehlers A, O'Neill S, Shao J, Englesbe M, Dimick JB, et al. Mesh overlap for ventral hernia repair in current practice. Surg Endosc. 2023;37(12):9476-82.