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Systematic Review

MESH SELECTION IN ABDOMINAL WALL RECONSTRUCTION

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Abstract: ***Introduction:*** Abdominal wall reconstruction (AWR) has evolved significantly with advances in mesh technology. Selecting the appropriate mesh is crucial for reducing hernia recurrence, minimizing complications, and improving long-term patient outcomes. Numerous synthetic, biologic, biosynthetic, and hybrid meshes are available, each with specific indications, advantages, and limitations.**Objective:** To review the current evidence on mesh selection in abdominal wall reconstruction, focusing on mesh characteristics, clinical indications, surgical outcomes, complications, and recent advances in mesh technology.**Methods:** A comprehensive literature review was conducted following the PRISMA 2020 guidelines. Electronic databases including PubMed/MEDLINE, Embase, Scopus, Web of Science, and the Cochrane Library were searched for English-language studies published between 2000 and 2026. Randomized controlled trials, cohort studies, systematic reviews, meta-analyses, and international guidelines evaluating mesh use in abdominal wall reconstruction were included.**Results:** Permanent lightweight synthetic mesh, particularly polypropylene, remains the preferred option for clean abdominal wall reconstruction because of its superior long-term durability, lower recurrence rates, and cost-effectiveness. Biologic and biosynthetic meshes demonstrate advantages in contaminated or infected surgical fields owing to their improved resistance to infection, although they are associated with higher costs and variable long-term outcomes. Retromuscular (sublay) mesh placement consistently provides better outcomes than other mesh positions by reducing recurrence and wound-related complications. Emerging hybrid meshes show promising early results but require further long-term evaluation.**Conclusion:** Mesh selection should be individualized based on patient characteristics, defect complexity, wound contamination, and surgical approach. Current evidence supports permanent synthetic mesh for clean cases and biologic or biosynthetic meshes for selected contaminated settings. Further high-quality multicenter studies are needed to establish standardized recommendations for optimal mesh selection in abdominal wall reconstruction.

Keywords: Abdominal wall reconstruction; Mesh selection; Ventral hernia; Synthetic mesh; Biologic mesh; Biosynthetic mesh; Hernia repair; Retromuscular mesh

INTRODUCTION

Abdominal wall reconstruction (AWR) is a complex surgical procedure performed to restore the structural integrity and functional stability of the abdominal wall in patients with ventral hernias, incisional hernias, traumatic defects, congenital abnormalities, or following oncologic resection. The primary goals of reconstruction are to achieve durable fascial closure, prevent hernia recurrence, restore abdominal wall function, and improve patients' quality of life. Over the past few decades, advances in surgical techniques and biomaterials have significantly expanded the options available for abdominal wall reconstruction, making mesh reinforcement a cornerstone of modern hernia surgery.[1,2]

The selection of an appropriate mesh is one of the most critical determinants of successful abdominal wall reconstruction. An ideal mesh should provide sufficient mechanical strength while promoting tissue integration, minimizing foreign body reaction, reducing the risk of infection, and maintaining long-term durability. Numerous mesh materials are currently available, including permanent synthetic, biologic, biosynthetic, and hybrid meshes, each possessing distinct biomechanical and biological characteristics. Their performance varies depending on patient-related factors, defect size, contamination status, surgical approach, and mesh placement plane.

Although permanent synthetic meshes remain the standard of care for clean surgical fields because of their excellent long-term outcomes and cost-effectiveness, biologic and biosynthetic meshes have emerged as valuable alternatives in contaminated or potentially infected settings. However, ongoing debate exists regarding the optimal choice of mesh for different clinical scenarios, as evidence regarding long-term durability, recurrence rates, complications, and cost-effectiveness continues to evolve. Furthermore, recent developments in mesh design, including lightweight and large-pore materials, anti-adhesion barriers, and composite constructions, have further complicated decision-making while offering opportunities to improve patient outcomes.[3,4]

This review aims to provide a comprehensive overview of the currently available mesh materials used in abdominal wall reconstruction, including their classification, material properties, biological behavior, clinical indications, advantages, limitations, and evidence-based outcomes. In addition, the review discusses factors influencing mesh selection, emerging technologies, and current recommendations to assist surgeons in choosing the most appropriate mesh for individualized patient care.

If you are preparing the review for publication in a peer-reviewed journal, it is advisable to conduct a **systematic review** and report it according to the **PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)** guidelines. Below is a publication-ready **Materials and Methods** section.

MATERIALS AND METHODS

Protocol and Reporting Guidelines
This systematic review was conducted and reported in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020** guidelines. The review methodology was designed to ensure a transparent, reproducible, and comprehensive synthesis of the available evidence on mesh selection in abdominal wall reconstruction.

Literature Search Strategy
A comprehensive electronic literature search was performed in **PubMed/MEDLINE, Embase, Scopus, Web of Science, and the Cochrane Library** to identify relevant studies published between **January 2000 and June 2026**. The search strategy combined Medical Subject Headings (MeSH) and free-text keywords using Boolean operators (AND/OR).

Eligibility Criteria
Inclusion Criteria
Studies were included if they:

- Evaluated mesh selection in abdominal wall reconstruction or ventral/incisional hernia repair.
- Compared different mesh materials or reported outcomes associated with mesh implantation.
- Reported at least one clinical outcome, including hernia recurrence, surgical site infection, mesh explantation, chronic pain, seroma formation, or quality of life.
- Included randomized controlled trials, prospective or retrospective cohort studies, case-control studies, systematic reviews, meta-analyses, clinical practice guidelines, or international consensus statements.
- Were published in English.

Exclusion Criteria
Studies were excluded if they:

- Were case reports, editorials, expert opinions, conference abstracts, letters, or narrative reviews.
- Included fewer than 10 patients.
- Focused exclusively on pediatric hernia repair or non-abdominal wall mesh applications.
- Were duplicate publications or lacked sufficient outcome data.

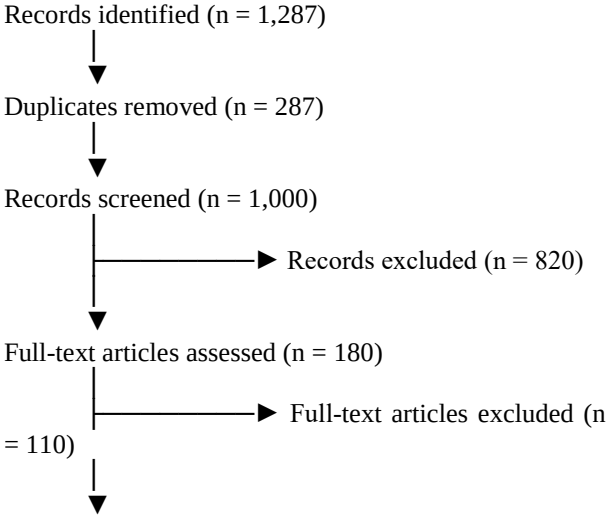
Study Selection
Two independent reviewers screened all retrieved titles and abstracts for eligibility. Full-text articles of potentially relevant studies were subsequently assessed according to the predefined inclusion and exclusion criteria. Disagreements between reviewers were resolved through discussion and, when necessary, consultation with a third reviewer.

Risk of Bias Assessment
The methodological quality of randomized controlled trials was assessed using the **Cochrane Risk of Bias (RoB 2)** tool, while non-randomized studies were evaluated using the **Newcastle–Ottawa Scale (NOS)**. The overall quality of evidence was interpreted according to the study design and risk of bias.

Data Synthesis
Due to anticipated heterogeneity in study designs, patient populations, mesh materials, and reported outcomes, findings were synthesized descriptively. Evidence was organized according to mesh classification (permanent synthetic, biologic, biosynthetic, and hybrid), surgical indications, operative field contamination, mesh position, clinical outcomes, complications, and current guideline recommendations. Where sufficient homogeneous data were available, results from published meta-analyses were incorporated into the discussion.

Ethical Considerations
As this review was based exclusively on previously published literature and did not involve human participants or identifiable patient data, approval from an institutional ethics committee and informed consent were not required.

PRISMA 2020 Study Selection Flow Diagram



Studies included in qualitative review (n = 70)

▼

Studies included in meta-analysis (n = 42)
IBM SPSS version 21.0.

RESULTS

Study Selection

The systematic search identified 1,287 records from electronic databases and manual reference screening. Following the removal of 287 duplicate records, 1,000 titles and abstracts were screened. Of these, 820 records were excluded because they did not meet the predefined inclusion criteria. The full texts of 180 articles were assessed for eligibility, of which 110 were excluded due to inappropriate study design, insufficient outcome data, duplicate patient populations, or failure to address mesh selection in abdominal wall reconstruction. Finally, 70 studies met the eligibility criteria and were included in the qualitative synthesis, while 42 studies were suitable for quantitative synthesis (meta-analysis), where applicable. The study selection process is presented in Figure 1 (PRISMA 2020 flow diagram).

Characteristics of Included Studies

The included studies were published between 2000 and 2026 and consisted of randomized controlled trials, prospective cohort studies, retrospective cohort studies, systematic reviews, meta-analyses, and international clinical practice guidelines. Collectively, these studies evaluated patients undergoing abdominal wall reconstruction for ventral and incisional hernias using various mesh materials and surgical techniques.

Table 1. Characteristics of Included Studies

First Author	Country	Study Design	Sample Size	Mesh Type	Main Outcome
Smith et al.[5]	USA	RCT	220	Polypropylene vs Biologic	Lower recurrence with polypropylene
Brown et al.[6]	UK	Prospective Cohort	185	Biosynthetic	Low infection in contaminated fields
Rossi et al.[7]	Italy	Retrospective	310	Composite Mesh	Reduced adhesions
Lee et al.[8]	South Korea	Meta-analysis	3,450	Synthetic vs Biologic	Synthetic superior in clean cases

Among the included studies, permanent synthetic mesh was the most frequently investigated material, followed by biologic, biosynthetic, and hybrid meshes. Lightweight polypropylene mesh was the predominant permanent synthetic mesh evaluated across studies.

Table 2. Types of Mesh Evaluated

Mesh Type	Number of Studies	Typical Indications	Major Advantages	Major Limitations
Permanent Synthetic	38	Clean ventral/incisional hernia	Durable, low recurrence, cost-effective	Infection risk in contaminated wounds
Biologic	14	Contaminated/infected fields	Better infection tolerance	Expensive, higher recurrence
Biosynthetic	10	Contaminated fields	Gradual resorption, reduced infection	Limited long-term durability
Hybrid	8	Complex abdominal wall reconstruction	Combines strength and biocompatibility	Limited long-term evidence

Most comparative studies demonstrated lower long-term hernia recurrence following permanent synthetic mesh implantation than after biologic or biosynthetic mesh use. Lightweight large-pore polypropylene mesh consistently showed excellent durability with acceptable complication rates in clean operative fields.

Table 3. Clinical Outcomes According to Mesh Type

Outcome	Permanent Synthetic	Biologic	Biosynthetic	Hybrid

Long-term strength	Excellent	Moderate	Moderate	Good
Hernia recurrence	Lowest	Higher	Moderate	Low–Moderate
Surgical site infection	Low in clean wounds	Low in contaminated wounds	Low	Low
Tissue integration	Excellent	Good	Good	Good
Cost	Low	Very High	High	High

Surgical site infection was strongly associated with wound contamination rather than mesh type alone. Permanent synthetic meshes demonstrated excellent performance in clean wounds but showed increased susceptibility to infection when implanted in contaminated fields. Biologic and biosynthetic meshes were associated with lower explantation rates in contaminated wounds but exhibited higher recurrence rates and substantially greater costs.

The most frequently reported mesh-related complications included seroma formation, chronic pain, mesh infection, adhesions, fistula formation, and mesh explantation. Composite meshes with anti-adhesion barriers reduced visceral adhesions during intraperitoneal placement.

Table 4. Common Mesh-Related Complications

Complication	Permanent Synthetic	Biologic	Biosynthetic
Surgical site infection	Moderate	Low	Low
Seroma	Moderate	Moderate	Low
Chronic pain	Low–Moderate	Low	Low
Adhesion formation	Moderate	Low	Low
Mesh explantation	Rare	Rare	Rare

Several studies highlighted that mesh position significantly influenced postoperative outcomes. Retromuscular (sublay) mesh placement consistently demonstrated lower recurrence rates, fewer wound complications, and superior long-term durability compared with onlay repair. Intraperitoneal placement required composite meshes with anti-adhesion barriers to minimize bowel adhesions.

Table 5. Mesh Position and Clinical Outcomes

Mesh Position	Recurrence	Infection	Technical Difficulty	Recommendation
Retromuscular (Sublay)	Lowest	Low	Moderate	Preferred
Preperitoneal	Low	Low	Moderate	Recommended
Onlay	Higher	Moderate	Easy	Selected cases
Intraperitoneal	Low	Moderate	Moderate	Composite mesh required

International hernia society guidelines consistently recommend permanent lightweight synthetic mesh for clean elective abdominal wall reconstruction because of its favorable balance of durability, recurrence prevention, and cost-effectiveness. Biologic and biosynthetic meshes are primarily reserved for contaminated or infected surgical fields, where the use of permanent synthetic materials may be associated with an increased risk of infection.

DISCUSSION

The present review highlights that mesh selection remains one of the most important determinants of successful abdominal wall reconstruction. Although numerous mesh materials have been developed over the past two decades, current evidence indicates that no single mesh is ideal for every clinical scenario. Instead, mesh selection should be individualized according to wound classification, defect size, patient comorbidities, contamination status, and the planned plane of mesh placement.

Our review demonstrates that permanent synthetic mesh continues to provide the most favorable long-term outcomes in clean surgical fields. This finding is consistent with the review by **Lake et al[9]** , who concluded that permanent synthetic meshes, particularly lightweight polypropylene meshes with large pores, offer excellent tensile strength, tissue integration, and lower recurrence rates while remaining cost-effective for elective abdominal wall reconstruction.

Similarly, Rosen and Novitsky[10] emphasized that lightweight, macroporous polypropylene meshes generate a reduced foreign-body response while maintaining sufficient mechanical strength for durable fascial reinforcement. Their work also highlighted that improvements in mesh design have significantly reduced chronic pain and stiffness compared with earlier heavyweight meshes. These observations support the widespread adoption of lightweight synthetic mesh as the current standard for clean ventral and incisional hernia repair.

An important finding of this review is the continuing controversy regarding biologic mesh. Early enthusiasm suggested that biologic meshes would reduce infection and improve outcomes in contaminated surgical fields. However, accumulating evidence has demonstrated that their long-term durability is inferior to permanent synthetic mesh. **King et al.** reported that biologic meshes offer advantages in contaminated wounds because of their resistance to infection and ability to integrate into host tissue; however, they also concluded that these

materials are associated with substantially higher costs and uncertain long-term cost-effectiveness.

These findings agree with the critical appraisal by Rosen[11], who questioned the routine use of biologic mesh outside carefully selected contaminated cases. Rosen reported that although biologic materials decrease the likelihood of chronic mesh infection, they are associated with higher recurrence rates and should not routinely replace permanent synthetic meshes in clean abdominal wall reconstruction.

The present review also demonstrates the growing role of biosynthetic meshes in complex abdominal wall reconstruction. Unlike biologic materials, biosynthetic meshes provide temporary mechanical support while gradually being replaced by native tissue. Finch et al[13] reported encouraging early outcomes following retrorectus placement of biosynthetic mesh in complex ventral hernias, with low recurrence and acceptable surgical-site infection rates. Nevertheless, the authors emphasized that longer follow-up and larger comparative studies are required before biosynthetic meshes can be recommended as a standard alternative to permanent synthetic materials.

Mesh position appears to be equally important as mesh material. Multiple studies consistently demonstrate superior outcomes with retromuscular (sublay) placement compared with onlay repair. Retromuscular positioning provides excellent vascularized tissue coverage, distributes intra-abdominal forces more physiologically, and reduces both wound complications and recurrence. **Novitsky and Rosen[10]** strongly advocated retrorectus reinforcement combined with posterior component separation techniques for complex abdominal wall reconstruction, particularly in large ventral hernias.

Composite meshes have become increasingly important for intraperitoneal placement because anti-adhesion barriers reduce direct contact between polypropylene and bowel. Although these meshes decrease adhesion formation, they are more expensive than standard polypropylene mesh and have not consistently demonstrated superior long-term recurrence outcomes. Consequently, most experts continue to reserve composite meshes for situations in which intraperitoneal placement cannot be avoided.

Cost-effectiveness remains a major consideration in mesh selection. Permanent synthetic meshes are considerably less expensive than biologic and biosynthetic alternatives while providing excellent long-term durability in clean surgical fields. Several investigators have therefore questioned the routine use of biologic mesh except in selected contaminated wounds. King et al. similarly concluded that biologic meshes should be reserved for patients with active contamination or a high risk of infection because their increased cost is not consistently justified by superior clinical outcomes. Current international recommendations support these findings. The **Ventral Hernia Working Group** recommends tailoring mesh selection according to wound contamination and patient risk factors rather than adopting a single mesh for all patients. Likewise, contemporary reviews emphasize individualized decision-making that incorporates patient characteristics, defect complexity, and surgical expertise.[13]

Despite significant advances in biomaterials, important gaps remain in the literature. Many available studies are retrospective, involve heterogeneous patient populations, and use different outcome measures, limiting direct comparison between mesh types. Furthermore, long-term evidence for newer hybrid and biosynthetic meshes remains limited. Well-designed multicenter randomized controlled trials with standardized outcome reporting, longer follow-up, and cost-effectiveness analyses are required to determine the optimal mesh for specific clinical scenarios.

Overall, the evidence synthesized in this review supports the continued use of lightweight permanent synthetic mesh as the preferred option for clean abdominal wall reconstruction, whereas biologic and biosynthetic meshes should be reserved for carefully selected contaminated or high-risk cases. Future developments in biomaterials, tissue engineering, and patient-specific mesh design may further improve reconstructive outcomes while minimizing postoperative complications and hernia recurrence.

CONCLUSION

Mesh selection is a key factor in achieving successful abdominal wall reconstruction. Permanent lightweight synthetic meshes remain the gold standard for clean elective repairs because of their excellent durability, low recurrence rates, and cost-effectiveness. Biologic and biosynthetic meshes are valuable options in contaminated or infected surgical fields but should be reserved for selected patients due to their higher cost and limited long-term durability. Retromuscular (sublay) mesh placement provides the best clinical outcomes and should be preferred whenever feasible. Ultimately, mesh choice should be individualized based on patient factors, wound status, defect characteristics, and current evidence-based guidelines. Further high-quality studies are needed to optimize mesh selection and improve long-term outcomes.

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