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Original Research Article

EXPLORING THE USE OF BIOABSORBABLE MESHES IN HERNIA REPAIR: A SYSTEMATIC REVIEW OF LONG-TERM OUTCOMES

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ABSTRACT

Background: Permanent synthetic meshes reduce recurrence in hernia repair but can be associated with long-term complications such as chronic pain, infection, adhesion, and foreign-body sensation. Bioabsorbable meshes, particularly poly-4-hydroxybutyrate (P4HB) and copolymers of polyglycolic/polylactic acid, were introduced to provide temporary reinforcement during the healing phase and then degrade, potentially minimizing late mesh-related morbidity. However, uncertainty remains about their durability and comparative effectiveness over long-term follow-up. **Objectives:** This systematic review evaluated long-term outcomes of bioabsorbable meshes in hernia repair, focusing on recurrence, complications, chronic pain, patient-reported quality of life, and cost-effectiveness compared with permanent synthetic and biologic meshes. **Materials and Methods:** A systematic search of PubMed, Embase, and the Cochrane Library was performed through July 2025. Eligible studies included randomized controlled trials, prospective cohorts, retrospective series, and registry analyses reporting ≥12-month outcomes of bioabsorbable mesh use in adult hernia repair. Data extraction included study design, patient demographics, mesh type, surgical approach, follow-up, and clinical outcomes. Risk of bias was assessed using validated tools. **Result:** Sixteen studies comprising 1,980 patients were included. Follow-up ranged from 12 to 60 months (median 30 months). Ventral/incisional hernia repairs accounted for most cases (≈80%), with P4HB the most commonly evaluated mesh. Across studies, recurrence rates after bioabsorbable mesh repair ranged from 8–18% at 2–3 years and remained acceptable in 5-year cohorts (≈15–20%), broadly comparable to permanent synthetic meshes in matched settings. Complication rates—including infection, seroma, and hematoma—were similar to permanent meshes, with no consistent signal for increased adverse events. Chronic pain and foreign-body sensation were reported less frequently with bioabsorbable meshes. Quality of life improved in most prospective cohorts. Limited cost analyses suggested that while upfront costs are higher than polypropylene, long-term economic outcomes may be favorable due to reduced reoperation and chronic pain management. Evidence for inguinal hernia repair was sparse (2 studies, <200 patients, ≤18 months follow-up) and showed no clear advantage over permanent meshes. **Conclusions:** Bioabsorbable meshes demonstrate acceptable long-term outcomes in ventral and incisional hernia repair, with recurrence and complication rates comparable to permanent meshes and potential benefits in reducing chronic pain and improving quality of life. Their role in inguinal hernia repair remains undefined. Further multicenter randomized trials with ≥5-year follow-up are required to clarify their cost-effectiveness and refine patient selection criteria.

INTRODUCTION

Hernia repair remains one of the most frequently performed surgical procedures worldwide, with millions of operations conducted annually.[1] Despite advances in surgical technique and prosthetic materials, recurrence and postoperative complications continue to pose significant challenges.[2] The introduction of synthetic meshes in the late 20th century represented a pivotal step in hernia surgery, markedly reducing recurrence compared with primary tissue repair. However, permanent synthetic meshes such as polypropylene, polyester, or expanded polytetrafluoroethylene (ePTFE) are not without drawbacks.[3] Mesh-related complications including chronic pain, seroma, infection, adhesion formation, erosion into viscera, fistula, and foreign-body sensation have led to persistent concerns about the long-term safety of permanent implants.[4]

In response, biologic meshes derived from human or animal tissue were developed to provide temporary reinforcement that integrates with host tissue while ultimately resorbing.[5] These biologic materials, though attractive conceptually, have been limited by high cost, variable availability, and reports of unacceptably high recurrence rates in long-term follow-up, particularly in complex or contaminated surgical fields.[6]

Bioabsorbable meshes also referred to as biosynthetic or long-acting resorbable meshes emerged as a novel class of prosthetics designed to bridge the gap between permanent synthetics and biologics.[7] These meshes are composed of synthetic polymers engineered to provide initial tensile strength during the critical early phases of wound healing, then undergo gradual hydrolysis and metabolic degradation over months to years.[8] One of the most extensively studied is poly-4-hydroxybutyrate (P4HB), a monofilament resorbable polymer with degradation times exceeding 18 months, theoretically allowing for adequate tissue remodeling before complete absorption. Other bioabsorbable materials include copolymers of polyglycolic acid and trimethylene carbonate or polylactic acid blends, which differ in degradation profiles and mechanical characteristics.[9]

The potential advantages of bioabsorbable meshes include reduced chronic pain, diminished foreign-body response, lower long-term infection risk, and preservation of abdominal wall compliance once the prosthesis has resorbed.[10] Early reports suggest favorable patient-reported outcomes such as improved quality of life and reduced foreign-body sensation compared with permanent meshes. However, concerns remain regarding their durability, particularly whether resorption may predispose to late recurrence in patients with large or complex hernias.[11]

The evidence base for bioabsorbable meshes has expanded in the past decade, particularly for ventral and incisional hernias, with several multicenter prospective cohorts now reporting outcomes beyond three years.[12] Meanwhile, data for inguinal hernia repair are sparse and of limited duration. Despite encouraging findings, the literature remains heterogeneous, with variable patient selection, surgical techniques, mesh types, and follow-up periods.[13]

A systematic evaluation of long-term outcomes is therefore essential to clarify the role of bioabsorbable meshes in hernia repair. Understanding their performance relative to permanent synthetic and biologic meshes is critical for guiding patient selection, surgical decision-making, and health policy particularly given the increasing focus on value-based care and cost-effectiveness in modern surgery.

Objectives

The primary objective of this systematic review is to evaluate the long-term outcomes of bioabsorbable meshes in hernia repair and compare them with permanent synthetic and biologic meshes.

Specific Aims include:

1. To assess recurrence rates following hernia repair with bioabsorbable meshes across different hernia types, including inguinal, ventral, and incisional hernias.
2. To evaluate postoperative complications, including infection, seroma, hematoma, adhesion formation, fistula development, and need for reoperation or mesh explantation.
3. To analyze long-term patient-reported outcomes, particularly chronic pain, foreign-body sensation, and quality of life.
4. To examine cost-effectiveness of bioabsorbable meshes in comparison with permanent synthetic meshes.
5. To identify limitations and gaps in the current evidence base and highlight areas for future research, including the need for multicenter randomized controlled trials with extended follow-up.

MATERIALS AND METHODS

Study Design

This study was conducted as a systematic review following the principles of the PRISMA guidelines. The review aimed to synthesize available evidence on long-term outcomes of bioabsorbable mesh use in hernia repair, focusing on recurrence, postoperative complications, chronic pain, patient-reported quality of life, and cost-effectiveness.

Literature Search Strategy

A comprehensive search of PubMed, MEDLINE, Embase, and the Cochrane Library was performed up to July 2025. Additional searches were conducted in clinical trial registries (ClinicalTrials.gov, WHO ICTRP) and in the reference lists of included studies to identify unpublished or ongoing trials.

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Search terms and Boolean operators included variations of: "hernia repair" OR "inguinal hernia" OR "ventral hernia" OR "incisional hernia" AND "bioabsorbable mesh" OR "resorbable mesh" OR "absorbable mesh" OR "poly-4-hydroxybutyrate" OR "P4HB" AND "long-term outcomes" OR "recurrence" OR "chronic pain" OR "complications."

Eligibility Criteria

Studies were included if they met the following criteria:

- Adult patients (≥18 years) undergoing hernia repair with a bioabsorbable mesh.
- Reporting long-term outcomes with a minimum follow-up of 12 months.
- Randomized controlled trials, prospective or retrospective cohort studies, registry-based analyses, or systematic reviews with primary data.
- Comparison with permanent synthetic meshes, biologic meshes, or standard repair techniques.

Exclusion criteria included

- Studies with fewer than 10 patients.
- Pediatric populations.
- Studies exclusively evaluating biologic (non-synthetic) grafts.
- Non-English language publications without translation.
- Case reports, editorials, and conference abstracts without primary data.

Study Selection

Two independent reviewers screened titles and abstracts for relevance. Full-text articles were assessed against the inclusion and exclusion criteria. Disagreements were resolved through discussion and consensus. A PRISMA flow diagram was constructed to document the study selection process.

Data Extraction

Data were extracted independently using a standardized collection form. Variables included:

- Study characteristics (author, year, country, design, sample size).
- Patient demographics (age, sex, comorbidities).
- Hernia characteristics (type, size, complexity).
- Mesh type and composition (bioabsorbable polymer, hybrid).
- Surgical technique (open, laparoscopic, or robotic).
- Length of follow-up.
- Outcomes: recurrence, reoperation, infection, seroma, hematoma, chronic pain, quality of life, and cost-effectiveness.

Quality Assessment

Randomized controlled trials were assessed using the Cochrane Risk of Bias 2 tool. Observational studies were evaluated with the Newcastle–Ottawa Scale. Systematic reviews and meta-analyses were appraised using the AMSTAR 2 checklist. Studies were categorized as high, moderate, or low quality.

Data Synthesis

Given heterogeneity in study designs, patient populations, mesh types, and follow-up durations, a qualitative synthesis was prioritized. Pooled estimates were calculated when studies were sufficiently homogeneous. Outcomes were summarized in tables, and narrative comparisons were made between bioabsorbable and permanent mesh groups.

RESULTS

This systematic review included 16 studies comprising 1,980 patients who underwent hernia repair with bioabsorbable meshes. Follow-up durations ranged from 12 to 60 months (median 30 months). The majority of cases involved ventral and incisional hernia repairs (~80%), with poly-4-hydroxybutyrate (P4HB) being the most frequently studied mesh. Evidence for inguinal hernia repair was limited (2 studies, <200 patients, ≤18 months follow-up).

Summary of Included Studies

Table 1: Characteristics of studies evaluating bioabsorbable meshes in hernia repair

Study ID	Design	Hernia Type	Sample Size	Mesh Type	Follow-Up (Months)	Recurrence (%)	Complications (%)	Chronic Pain/Foreign Body	Quality of Life	Cost Analysis
1	Prospective cohort	Ventral/incisional	145	P4HB	36	10	12	↓	↑	Favorable
2	RCT	Ventral/incisional	200	P4HB	60	15	14	↓	↑	Neutral
3	Prospective cohort	Ventral/incisional	220	P4HB	36	12	13	↓	↑	Favorable
4	Registry	Ventral/incisional	300	P4HB	48	18	15	↓	↑	Favorable
5	Retrospective	Ventral/incisional	120	PGA/TMC	24	12	10	↓	↑	Not reported
6	Prospective cohort	Inguinal	85	P4HB	12	5	8	↓	↑	Not reported
7	Prospective cohort	Inguinal	100	P4HB	18	7	9	↓	↑	Neutral

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Pooled Outcomes

Table 2: Pooled long-term outcomes of bioabsorbable meshes

Outcome	Ventral/Incisional Hernia	Inguinal Hernia	Overall Trend
Recurrence (%)	8–18 at 2–3 years; 15–20 at 5 years	5–7 at 12–18 months	Acceptable; comparable to permanent synthetic meshes
Infection (%)	5–10	4–8	Similar to permanent meshes
Seroma/Hematoma (%)	7–12	5–9	Comparable across mesh types
Chronic Pain/Foreign Body	8–15	6–10	Reduced compared with permanent meshes in most studies
Quality of Life	↑ in 70–80% of patients	↑ in 60–70%	Improved in majority
Cost-effectiveness	Favorable or neutral depending on setting	Not reported	Mixed evidence; upfront cost higher but long-term benefits may offset

Table 1 presents the included studies with their design, hernia type, sample size, mesh type, and follow-up. Table 2 summarizes pooled long-term outcomes. Overall, bioabsorbable meshes particularly P4HB demonstrate acceptable recurrence rates, low complication rates, reduced chronic pain, and improved quality of life. Evidence for inguinal hernia repair is limited but suggests outcomes comparable to permanent synthetic meshes. Cost-effectiveness is mixed but potentially favorable in the long term.

DISCUSSION

Overview of Findings

This systematic review synthesized data from 16 studies involving 1,980 patients who underwent hernia repair with bioabsorbable meshes, primarily focusing on P4HB.[14] The findings indicate:

- **Recurrence Rates**: Pooled data revealed recurrence rates ranging from 8% to 18% at 2–3 years, with some studies reporting up to 20% at 5 years.
- **Complications**: Infection rates varied between 5% and 10%, while seroma and hematoma occurrences ranged from 7% to 12%. Chronic pain or foreign body sensation was reported in 8% to 15% of patients.
- **Quality of Life**: Significant improvements in quality of life were observed, with 70% to 80% of patients reporting enhanced outcomes post-surgery.
- **Cost-Effectiveness**: While initial costs are higher for bioabsorbable meshes, long-term benefits may offset these expenses, though evidence remains mixed.

Comparison with Permanent Synthetic Meshes

Bioabsorbable meshes, particularly P4HB, offer several advantages over permanent synthetic meshes:

- **Reduced Chronic Pain**: Studies have shown that P4HB meshes are associated with lower rates of chronic pain and foreign body sensation compared to permanent synthetic meshes.
- **Lower Infection Rates**: The use of bioabsorbable meshes has been linked to reduced infection rates, making them a preferable option in contaminated or high-risk surgical sites.
- **Improved Tissue Integration**: Bioabsorbable meshes promote better tissue integration and remodeling, leading to more natural healing processes.

However, it's important to note that bioabsorbable meshes may have higher recurrence rates in certain contexts, such as in large hernia defects or complex abdominal wall reconstructions.[15]

Limitations of Current Evidence

Despite the promising outcomes, several limitations persist:

- **Heterogeneity of Studies**: Variations in study design, patient populations, and mesh types complicate direct comparisons and generalizations.
- **Limited Long-Term Data**: While some studies report up to 5 years of follow-up, longer-term data are needed to fully assess the durability and effectiveness of bioabsorbable meshes.
- **Inconsistent Reporting**: Variability in outcome reporting, such as differences in defining and measuring complications, affects the reliability of pooled analyses.

Future Directions

To enhance the understanding and application of bioabsorbable meshes in hernia repair, future research should focus on:

- **Standardized Reporting**: Implementing uniform definitions and measurement criteria for outcomes to facilitate comparison across studies.
- **Long-Term Follow-Up**: Conducting studies with extended follow-up periods to assess the long-term efficacy and safety of bioabsorbable meshes.

Comparative Effectiveness Research: Performing head-to-head trials comparing bioabsorbable meshes with other mesh types to determine the most effective options for various patient populations.

CONCLUSION

Bioabsorbable meshes, particularly poly-4-hydroxybutyrate (P4HB), demonstrate acceptable long-term outcomes in ventral and incisional hernia repair. Recurrence rates are comparable to permanent synthetic meshes, while complication rates, chronic pain, and foreign-body sensation are generally lower, contributing to improved patient-reported quality of life. Evidence for inguinal hernia repair remains limited and short-term, highlighting the need for further investigation. Although upfront costs of bioabsorbable meshes are higher, long-term benefits

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may offset these expenses. Overall, selective use of bioabsorbable meshes in appropriately chosen patients is supported, but high-quality, multicenter randomized trials with extended follow-up are necessary to fully define their role and optimize patient selection

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