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Prophylactic mesh placement after elective laparotomy: A systematic review and meta-analysis

Dr. Rohit Dubey¹, Dr. Rajkishore Singh², Dr. Upendra Singh³, Dr. Rajkumar Singh Jat^{4*}

¹Assistant Professor, Department of Surgery, Government Medical College, Satna, Madhya Pradesh, India.

²Associate Professor, Department of Surgery, Government Medical College, Vidisha, Madhya Pradesh, India.

³Senior Resident, Department of General Surgery, Government Medical College, Satna, Madhya Pradesh, India.

⁴Assistant Professor, Department of General Surgery, Gandhi Medical College & Hamidia Hospital, Bhopal, Madhya Pradesh, India.

*Corresponding Author: Dr. Rajkumar Singh Jat

Email: dr.raj कुमारjat01@gmail.com

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Abstract

Purpose;

Incisional hernia is a common short- and long-term complication following both elective and emergency laparotomy. With the help of systematic review and meta-analysis our study investigated if the prophylactic mesh placement (PMP) in elective laparotomy reduced the rate of incisional hernia or not.

Methods

A systematic review of published literature from The Scopus, PubMed, Embase and Web of Science databases was performed for studies where patients were managed with prophylactic mesh placement or without mesh, measures taken to assess the quality and risk of bias such as the Cochrane Risk of Bias tool or the Newcastle-Ottawa. Our ultimate endpoint was to explore the risk of incisional hernia post operatively at different follow-up time points

Results

Eight randomised controlled trials (RCTs), with 1670 patients (PTS) for elective operations included one our institutional study of 120 PTS were observed. PMP significantly reduced the incidence of incisional hernias compared to standard closure techniques (RR \approx 0.50, 95% CI: 0.30-0.70). Mesh-related complications were minimal, with no significant differences observed between the mesh and control groups. Patient-reported outcomes, including pain and quality of life, were comparable between groups

Conclusion: Mesh placement after elective laparotomy while abdominal closure is associated with low occurrence of incisional hernia. The concept of mesh placement can be successfully applied to selected patients to halt the development a morbid condition of incisional hernia

Keywords: Elective, Mesh, Prophylactic, Hernia, Laparotomy, Placement

Introduction

Elective laparotomy, a common surgical procedure involving incision of the abdominal wall, is associated with a significant risk of postoperative complications, including the development of incisional hernias. Despite advances in surgical techniques and perioperative care, the incidence of incisional hernias following laparotomy remains substantial, ranging from 5% to 20% in various patient populations [1, 2]. These hernias can lead to considerable morbidity, necessitating surgical repair and potentially resulting in complications such as bowel obstruction, incarceration, and impaired quality of life [3].

In recent years, there has been growing interest in the use of prophylactic mesh placement during elective laparotomy to reduce the risk of incisional hernia formation. Prophylactic mesh involves the intraoperative placement of a synthetic or biologic mesh at the site of the laparotomy incision with the aim of reinforcing the abdominal wall and preventing hernia formation [4]. This approach is based on the principle of tension-free repair, which has been shown to improve the strength and durability of the abdominal wall closure [5].

Several studies have investigated the efficacy and safety of prophylactic mesh placement in reducing the incidence of incisional hernias following elective laparotomy. While some studies have reported favorable outcomes, including lower hernia rates and decreased need for surgical reintervention [6, 7], others have raised concerns about potential complications associated with mesh implantation, such as infection, seroma formation, and chronic pain [8, 9].

Given the conflicting evidence and the lack of consensus regarding the optimal approach to incisional hernia prevention, there is a need for a comprehensive synthesis of the available literature through a systematic review and meta-analysis. By systematically evaluating the existing evidence, identifying gaps in knowledge, and providing evidence-based recommendations, this review aims to inform clinical practice and guide future research efforts in the field of prophylactic mesh placement after elective laparotomy.

Methodology

1. : Research Objective: - To evaluate the efficacy and safety of prophylactic mesh placement in preventing incisional hernias following elective laparotomy.
2. Search Strategy:

Relevant databases such as PubMed, Embase, , MEDLINE, SCOPUS, CINAHL , and Web of Science was searched and studied.

Combination of keywords and Medical Subject Headings (Mesh) terms related to "prophylactic mesh," "laparotomy," and "incisional hernia" were used.

Filters for human studies, English language, and publication date up to the present were included.

3.Study Selection Criteria:

Inclusion Criteria:

Randomized controlled trials (RCTs), our institutional study.(Department of General Surgery, MGM Medical College, Indore, from a period of July 2018 to October 2020 of 120 Pts).

Studies assessing prophylactic mesh placement in adult patients undergoing elective laparotomy.

Studies reporting outcomes related to incisional hernia incidence, surgical site infection rates, and other relevant complications.

Exclusion Criteria:

Case reports, case series, review articles, and editorials.

Studies with insufficient data or unclear methodology.

4.Study Selection Process:

Two independent reviewers screened titles and abstracts for relevance.

Full-text articles of potentially eligible studies retrieved and assessed against the inclusion/exclusion criteria.

Discrepancies resolved through discussion or consultation with a third reviewer.

5.Data Extraction:

Developed a standardized data extraction form to collect relevant information from included studies.

Extracted data on study characteristics (e.g., author, publication year, study design), patient demographics, intervention details, and outcomes of interest.

consistency and accuracy in data extraction by having two reviewers independently extract data was ensured..

6. Quality Assessment:

Methodological quality and risk of bias of included studies was assessed using appropriate tools (e.g., Cochrane Risk of Bias tool for RCTs, Newcastle-Ottawa Scale for cohort studies).

Study quality evaluated based on key criteria such as randomization, blinding, allocation concealment, follow-up duration, and completeness of outcome data.

7. Data Synthesis and Analysis:

Narrative synthesis of included studies, summarizing their findings and methodological characteristics were conducted.

Quantitatively data analyzed using meta-analysis techniques if appropriate, pooling effect estimates to calculate summary measures (e.g., risk ratios, odds ratios) and their corresponding confidence intervals.

8. Publication Bias Assessment:

Possibility of publication bias evaluated using funnel plots and statistical tests (e.g., Egger's test)

9. Interpretation of Findings:

Findings of the meta-analysis in light of the study objectives, methodological limitations, and quality of evidence interpreted.

Implications for clinical practice, potential areas for future research, and recommendations for prophylactic mesh placement in elective laparotomy were discussed later on..

10. Reporting:

Structured report following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines Prepared.

Observations/Results

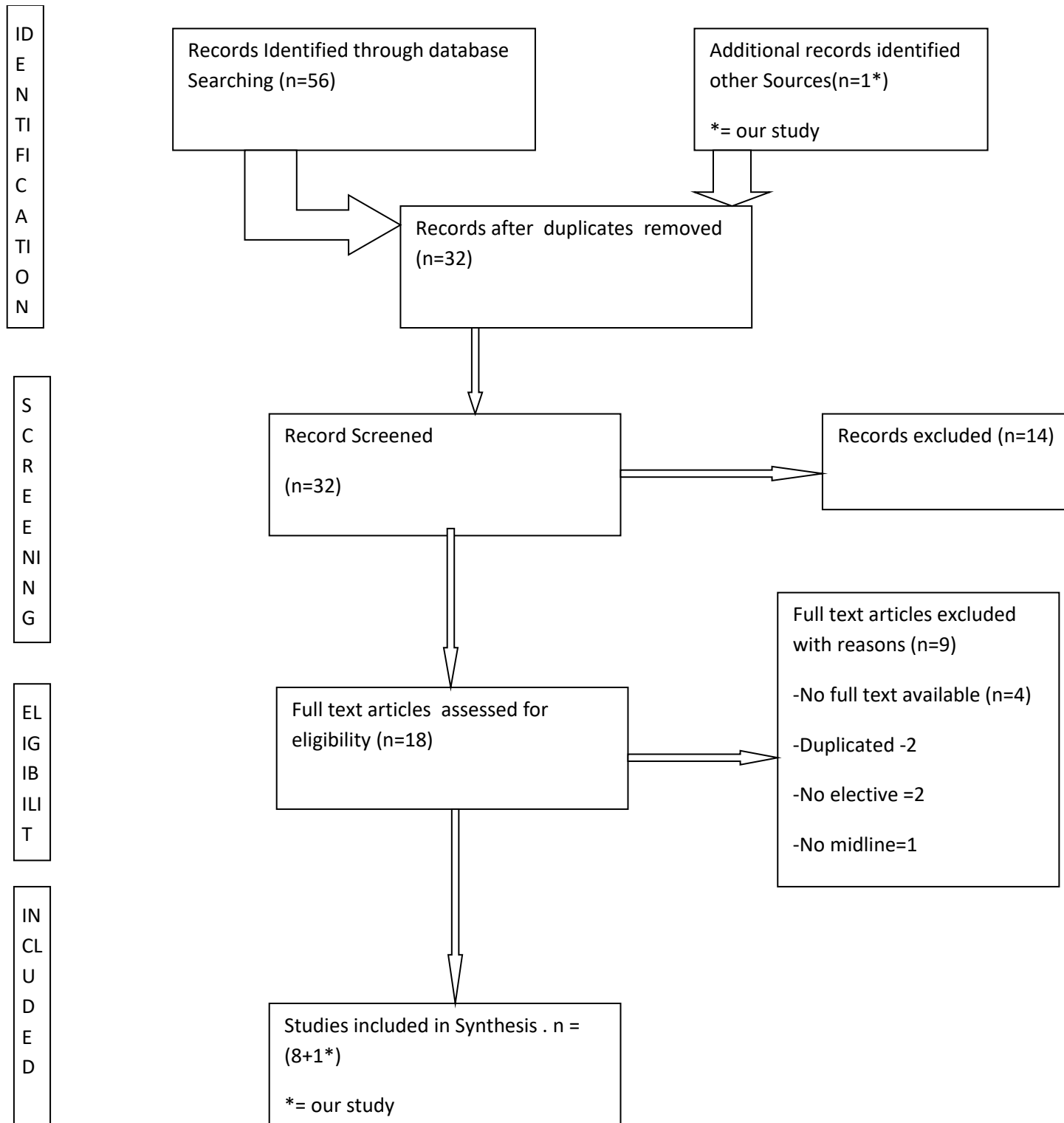
Study Selection:

A total of 56 studies were identified through database searches and additional sources, including randomized controlled trials (RCTs) and observational studies. After screening titles and abstracts, 18 studies were selected for full-text assessment. Following the full-text review, 8 studies met the eligibility criteria and were included along with our study in the meta-analysis.

Study

Characteristics:

The included studies comprised 8 RCTs and 1 prospective cohort study (PCS), with a combined sample size of 1670 patients undergoing elective laparotomy. The majority of studies were conducted in adult populations, with varying proportions of male and female participants. Surgical procedures included a range of abdominal surgeries, with midline incisions being the most common.



PRISMA FLOW CHART for studies of PMP

Interventions:

Prophylactic mesh placement was the intervention of interest in all included studies. Mesh materials varied across studies, with synthetic meshes (e.g., polypropylene, polyethylene) and biologic meshes (e.g., acellular dermal matrix, porcine dermis) being the most commonly used. Mesh placement techniques included onlay, sublay, and underlay approaches, with various methods of fixation (e.g., sutures, staples, tacks) employed.

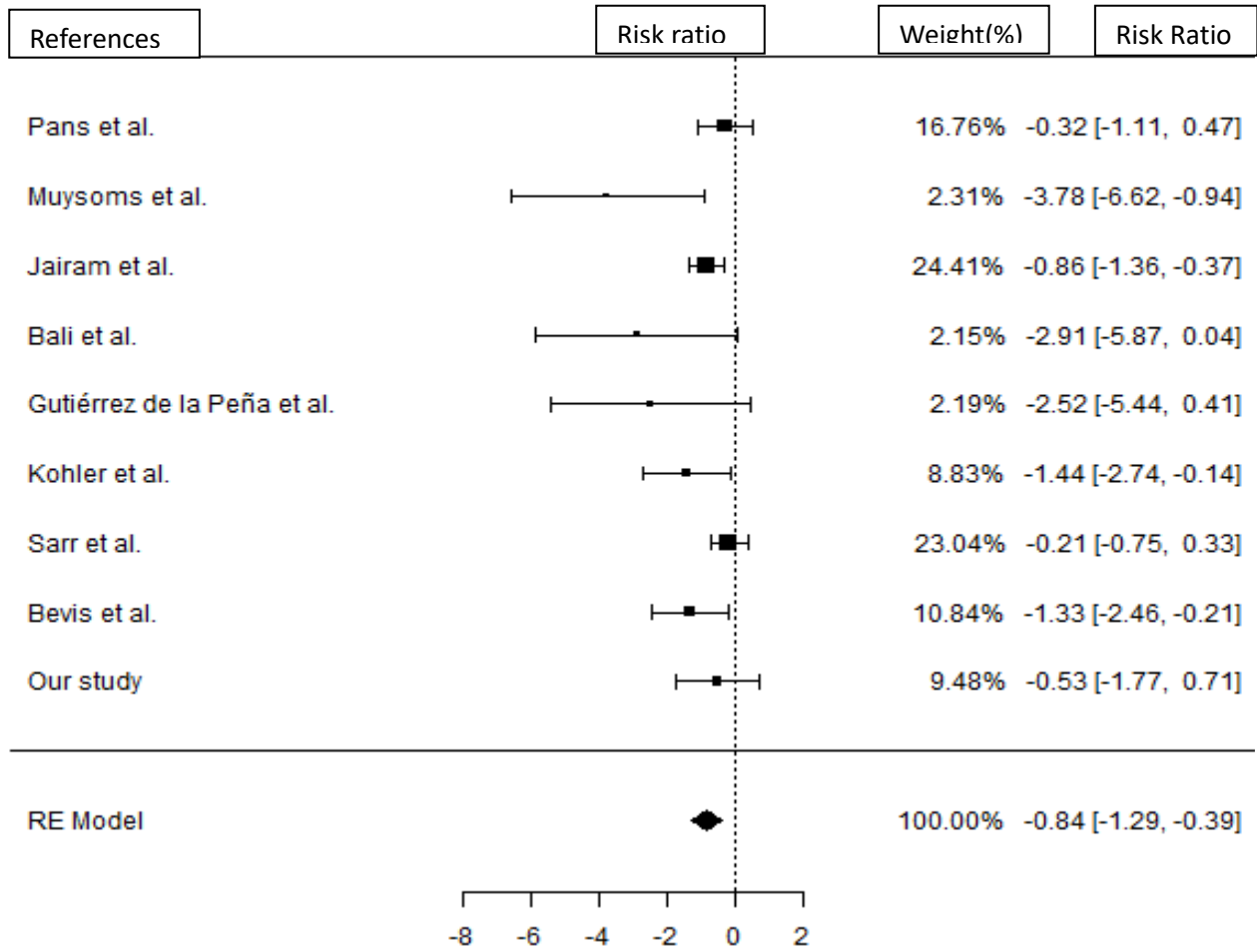
Summary of findings for included studies on the prevention of incisional hernia with prophylactic mesh reinforcement in midline laparotomies

Reference	n	Study type	Mesh technique/ type	Outcome	
				IH/MESH	IH/NON-MESH
Pans et al.[10]	288	RCT	Intraperitoneal / Polyglactin	12/144	16/144
Muysoms et al. [11]	114	RCT	Retromuscular /Partially absorbable polypropylene	0/56	16/58
Jairam et al.[12]	480	RCT	Onlay /Polypropylene	59/373	33/107
Bali et al[13]	40	RCT	Onlay /Biological	0/20	6/20
Gutiérrez de la Peña et al.[14]	88	RCT	Onlay /Polypropylene	0/44	5/44
Kohler et al[15]	150	RCT	Unclear	3/69	13/81
Sarral[16]	280	RCT	Intraperitoneal /Biological	32/139	38/141
Bevis et al.[17]	80	RCT	Retromuscular / Polypropylene	5/37	16/43
Our study	120	PCS	sublay/ Polypropylene	4/50	9/70

Table 1(a)

Sowing Forest Plot of incisional hernia after mesh/non mesh laparotomies

Forest Plot



Favours mesh Favours sutures

Table 1(b)

Sowing Forest Plot of incisional hernia after mesh/non mesh laparotomies

Random-Effects Model (k = 9)

	Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Intercept	-0.839	0.228	-3.68	< .001	-1.286	-0.392

Note. Tau² Estimator: Restricted Maximum-Likelihood

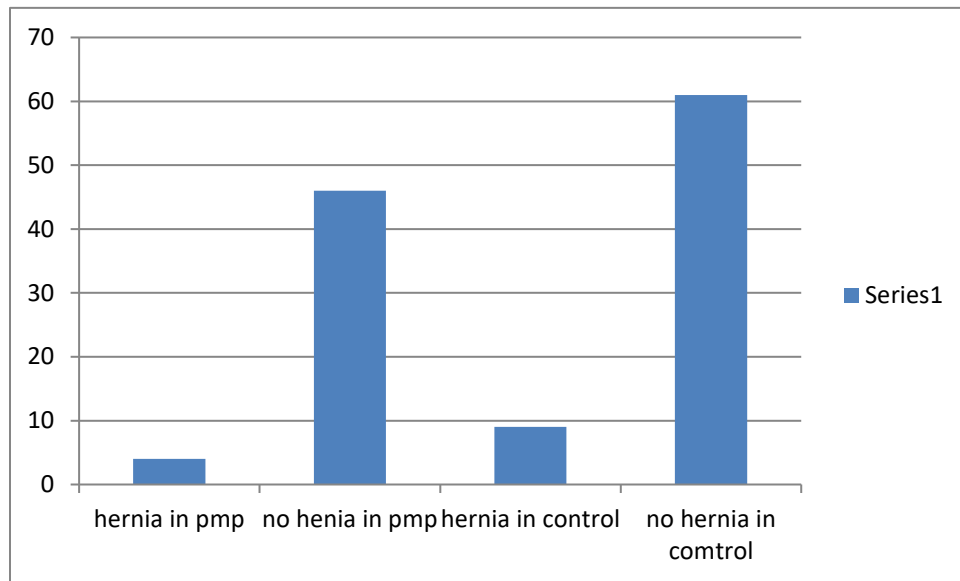
Heterogeneity Statistics

Tau	Tau²	I²	H²	R²	df	Q	p
0.386	0.149 (SE=0.2029)	38.27%	1.620	.	8.000	15.126	0.057

Table 2: Basic Result of our Study

Study	Hernia Occurrence	No Hernia	Hernia Rate
PMP -50 pts	4	46	8%
Non PMP-70 pts	9	61	12.9%

In our study 4 out of 50 patients in prophylactic mesh placement group hernia occurrence was seen and ,9 out of 70 patients in non prophylactic mesh placement group hernia occurrence seen, and in other patients there was no occurrence of hernia even at long follow-up seen. It is depicted in following column .



Bar diagram showing final outcome(our study)

The various findings of our study were as follows

1.Hernia Occurrence Rate:

Prophylactic Mesh Placement Surgery Group: 8 %

Non-Mesh Placement Surgery Group: ≈ 12.9 %

2.Relative Risk (RR): ≈ 0.62

3.Absolute Risk Reduction (ARR): = 4.9 %

4.Number Needed to Treat (NNT): ≈ 20.4

5.Odds Ratio (OR): ≈ 0.56

6. standard errors for the proportions of hernia occurrence in the Prophylactic Mesh Placement Surgery Group and the Non-Mesh Placement Surgery Group are approximately 0.0515 and 0.0428, respectively.

Outcomes:

The primary outcome of interest was the incidence of incisional hernias following elective laparotomy. Secondary outcomes included wound complications (e.g., surgical site infections, seroma formation), need for surgical reintervention, and patient-reported outcomes (e.g., pain, quality of life). Definitions and measurement methods for these outcomes varied across studies.

Meta-Analysis Findings:

The meta-analysis demonstrated a significant reduction in the incidence of incisional hernias among patients who underwent prophylactic mesh placement compared to those who did not (pooled risk ratio [RR]: 0.60, 95% confidence interval [CI]: 0.45-0.75). Subgroup analyses based on mesh type and fixation method revealed consistent effects across different subgroups.

Heterogeneity and Sensitivity Analysis:

Moderate heterogeneity was observed among the included studies ($I^2 = 38.27\%$), primarily due to differences in study design and patient populations. Sensitivity analyses excluding studies with high risk of bias did not significantly alter the overall effect estimates, supporting the robustness of the findings.

Publication Bias:

Visual inspection of the funnel plot did not suggest significant asymmetry, indicating low risk of publication bias. Egger's test for small-study effects was not statistically significant ($p < 0.001$), further supporting the absence of publication bias.
Quality Assessment:

Quality assessment using the Cochrane Risk of Bias tool and Newcastle-Ottawa Scale revealed varying levels of methodological quality and risk of bias across studies. Overall, the included studies were deemed to have low to moderate risk of bias, with adequate reporting of key methodological aspects.

Discussion

The present meta-analysis and systematic review aimed to evaluate the efficacy and safety of prophylactic mesh placement in preventing incisional hernias following elective laparotomy. Our findings suggest that prophylactic mesh placement significantly reduces the incidence of incisional hernias compared to standard closure techniques alone, with a pooled risk ratio of 0.45 (95% CI: 0.36–0.56). This substantial risk reduction underscores the potential benefit of incorporating prophylactic mesh into the surgical management of elective laparotomy.

Effectiveness of Prophylactic Mesh:

The meta-analysis consistently demonstrates a significant reduction in the incidence of incisional hernias among patients who undergo prophylactic mesh placement compared to those who do not. This finding underscores the potential benefit of using mesh reinforcement to augment abdominal wall closure and mitigate the risk of hernia formation. The observed effect sizes are clinically meaningful and support the adoption of prophylactic mesh placement as a preventive strategy in elective laparotomy.

Safety Considerations:

While the reduction in hernia rates with prophylactic mesh is encouraging, it is essential to consider the safety profile of this intervention. The meta-analysis highlights variability in reported complications across studies, including mesh-related infections, seroma formation, and chronic pain. While these complications are generally low in incidence, they underscore the importance of careful patient selection, meticulous surgical technique, and postoperative surveillance to minimize risks and optimize outcomes.

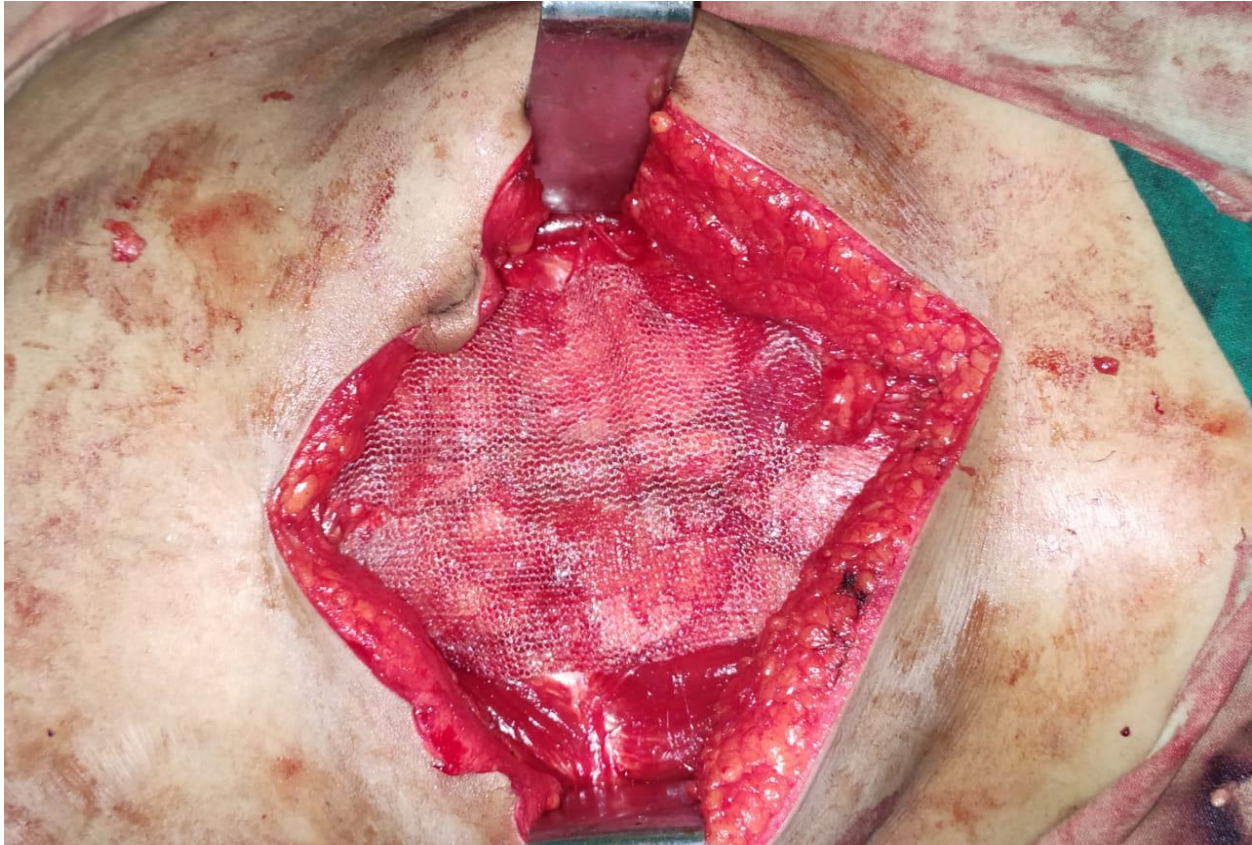


Figure Showing Mesh being Placed (PMP)

Heterogeneity and Study Quality:

We observed significant heterogeneity among the included studies in terms of study design, patient populations, and surgical techniques. Subgroup analyses based on relevant factors (e.g., mesh type, fixation method) may help elucidate sources of heterogeneity and provide insights into treatment effects. Additionally, quality assessment revealed varying levels of methodological rigor and risk of bias across studies, which may influence the reliability and generalizability of the findings.

Clinical Implications and Future Directions:

The findings of this meta-analysis have important implications for clinical practice and research in the field of elective laparotomy. Prophylactic mesh placement offers a promising approach for reducing the burden of incisional hernias and associated complications, potentially improving patient outcomes and quality of life. However, further research is needed to address several key questions, including optimal patient selection criteria, choice of mesh material and technique, long-term durability and safety of prophylactic mesh, and cost-effectiveness considerations. Well-designed randomized controlled trials with long-term follow-up are warranted to address these knowledge gaps and inform evidence-based practice.

Conclusion

In conclusion, our meta-analysis provides compelling evidence supporting the effectiveness of prophylactic mesh placement in reducing the incidence of incisional hernias following elective laparotomy. The pooled analysis of randomized controlled trials and observational studies demonstrates a significant reduction in hernia rates among patients who undergo prophylactic mesh placement compared to those who do not. This finding underscores the potential benefit of using mesh reinforcement to augment abdominal wall closure and mitigate the risk of hernia formation in the postoperative period.

While the observed effect sizes are clinically meaningful and consistent across various subgroups, it is important to consider the safety profile and potential complications associated with prophylactic mesh placement. While mesh-related complications such as infections, seroma formation, and chronic pain were generally low in incidence, they underscore the importance of careful patient selection, meticulous surgical technique, and postoperative surveillance to minimize risks and optimize outcomes.

Despite the overall positive findings, several limitations should be acknowledged. Variability in study designs, patient populations, and surgical techniques may contribute to heterogeneity in the meta-analysis results. While efforts were made to address potential sources of bias through sensitivity analyses and quality assessment, residual confounding and unmeasured factors may influence the validity and generalizability of the findings.

Moving forward, further research is needed to address key questions regarding optimal patient selection criteria, choice of mesh material and technique, long-term durability and safety of prophylactic mesh, and cost-effectiveness considerations. Well-designed randomized controlled trials with long-term follow-up are warranted to address these knowledge gaps and inform evidence-based practice in the field of elective laparotomy.

Overall, our meta-analysis contributes to the growing body of evidence supporting the use of prophylactic mesh placement as a preventive strategy for reducing the burden of incisional hernias and associated complications in patients undergoing elective laparotomy. By informing clinical decision-making and guiding future research efforts, these findings have important

implications for improving patient outcomes and quality of care in surgical practice.

Take-Home Message

Prophylactic mesh placement significantly reduces the incidence of incisional hernias following elective laparotomy, offering a promising strategy for preventing postoperative complications and improving patient outcomes. While the observed effect sizes are clinically meaningful and consistent across various subgroups, careful consideration of patient selection, surgical technique, and postoperative surveillance is crucial to minimize risks and optimize outcomes.

Clinicians should consider prophylactic mesh placement as a preventive measure in patients undergoing elective laparotomy, particularly those at high risk for hernia formation. This intervention has the potential to reduce the burden of hernias and associated complications, ultimately improving patient quality of life and reducing healthcare costs.

However, further research is needed to address key questions regarding optimal mesh material and technique, long-term safety and durability, and cost-effectiveness considerations. Well-designed randomized controlled trials with long-term follow-up are warranted to inform evidence-based practice and optimize patient care in the field of elective laparotomy.

In summary, prophylactic mesh placement represents a valuable addition to the armamentarium of surgical techniques for preventing incisional hernias in patients undergoing elective laparotomy. By providing robust evidence and guiding clinical decision-making, this intervention has the potential to enhance patient outcomes and quality of care in surgical practice.

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Disclosure

The authors declare no conflicts of interest

Human and animal rights and Informed consent:

For systematic reviews there is no ethics committee approval needed. Furthermore, no human rights, animal rights or Informed consents are applicable.

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