International Surgery Journal
Bursalyan D et al. Int Surg J. 2026 Dec;13(12):2530-2535
https://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20264362

Systematic Review

Short-term recurrence following robotic versus laparoscopic hiatal hernia repair with and without mesh reinforcement: a systematic review

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Received: 26 August 2026
Revised: 02 October 2026
Accepted: 27 October 2026

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ABSTRACT

Hiatal hernia repair is associated with clinically important anatomic recurrence, and the role of crural mesh reinforcement remains controversial. This systematic review evaluated recurrence after minimally invasive hiatal and paraesophageal hernia repair, with emphasis on mesh reinforcement and robotic versus conventional laparoscopic approaches. PubMed and Google Scholar were searched for English-language human studies published from January 2000 through December 2023 using combinations of terms related to hiatal or paraesophageal hernia, mesh reinforcement, recurrence, laparoscopy, and robotic surgery. Primary studies reporting postoperative recurrence after laparoscopic or robotic repair were eligible; case reports, reviews, editorials, open-only series, and studies without recurrence outcomes were excluded. Eleven primary studies were retained for qualitative synthesis after re-screening against the prespecified eligibility criteria. Early randomized and observational evidence suggested that mesh reinforcement can reduce early anatomic recurrence in selected repairs; however, longer-term randomized follow-up did not consistently demonstrate a durable recurrence advantage. Robotic repair was feasible, but comparative evidence did not establish a consistent recurrence benefit over laparoscopy. Interpretation was limited by heterogeneity in hernia phenotype, mesh material, recurrence definition, surveillance modality, and follow-up duration. Mesh reinforcement may reduce early recurrence in selected patients, but current evidence does not support routine mesh placement or superiority of the robotic platform. Standardized recurrence definitions, objective surveillance, and long-term comparative studies are needed.

Keywords: Hiatal hernia, Paraesophageal hernia, Mesh, Robotic surgery, Laparoscopy, Recurrence, Cruroplasty

INTRODUCTION

Hiatal and paraesophageal hernias are common foregut disorders. Minimally invasive repair has become the dominant operative strategy for symptomatic disease, but postoperative recurrence remains a persistent limitation, particularly after repair of large type III and IV hernias. Reported recurrence varies widely because studies use different anatomic thresholds, surveillance modalities, and follow-up intervals.[1-3]

Mesh reinforcement of the crural closure was introduced to improve mechanical durability when the hiatus is large, the crura are attenuated, or primary closure is under tension. Early randomized and observational studies suggested lower radiographic recurrence with mesh, but concerns regarding erosion, fibrosis, stenosis, dysphagia, and complexity of revisional surgery have prevented universal adoption.[4-8]

The controversy is further complicated by mesh composition. Permanent synthetic, biologic, and

absorbable materials have different risk profiles, and an early reduction in radiographic recurrence does not necessarily translate into durable symptom relief, improved quality of life, or fewer reoperations. Long-term randomized follow-up has attenuated several apparent early benefits of reinforcement.[9-12]

Robotic-assisted repair has expanded because three-dimensional visualization, wristed instrumentation, and intracorporeal suturing may facilitate mediastinal dissection and crural reconstruction. Comparative studies, however, have not consistently demonstrated that these technical advantages translate into superior recurrence outcomes.[13-15]

The objective of this systematic review was to evaluate recurrence following minimally invasive hiatal hernia repair with and without mesh reinforcement and to examine whether recurrence outcomes differ between robotic and conventional laparoscopic approaches.

We hypothesized that mesh reinforcement would be associated with lower early anatomic recurrence in selected repairs; however, we anticipated that heterogeneity in operative technique, recurrence assessment, and follow-up, together with limited robotic-specific comparative evidence, would preclude definitive conclusions regarding routine mesh use or platform superiority.

METHODS

Reporting framework and review question

This revision was structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 reporting framework.[16]

The review question was: among adults undergoing minimally invasive hiatal or paraesophageal hernia repair, how do recurrence outcomes differ with mesh-reinforced versus suture-only crural closure, and what evidence exists regarding robotic versus conventional laparoscopic repair?

Search strategy and study period

PubMed and Google Scholar were searched for English-language human studies published from 1 January 2000 through 31 December 2023. Search concepts included combinations of: ("hiatal hernia" or "hiatus hernia" or "paraesophageal hernia") and ("mesh" or "mesh reinforcement" or "cruroplasty") and ("recurrence"); and ("hiatal hernia" or "paraesophageal hernia") and ("robotic" or "robot-assisted") and ("laparoscopic" or "laparoscopy") and ("recurrence" or "outcomes"). Reference lists of relevant evidence syntheses were also examined to identify primary studies. The journal-requested interval of September 2014 through October 2015 falls within this prespecified publication period.

Eligibility criteria

Eligible studies included adults undergoing laparoscopic or robotic hiatal/paraesophageal hernia repair and reported postoperative recurrence with a defined follow-up interval. Mesh studies were required to describe the reinforcement strategy or permit comparison with suture-only repair; robotic studies were required to report recurrence or comparative outcomes relevant to recurrence.

Case reports, narrative reviews, systematic reviews/meta-analyses, editorials, pediatric studies, open-only series, and studies without recurrence outcomes were excluded from the primary-study synthesis.

Study selection and data extraction

Candidate reports were evaluated for eligibility on the basis of title and abstract review followed by full-text assessment. The evidence set underlying the original literature review was re-evaluated using the prespecified eligibility criteria, and the search was repeated through the defined end date to verify the primary literature. Eleven primary studies were retained for qualitative synthesis.

Extracted variables included study design, operative approach, reinforcement strategy and mesh material when applicable, comparator, method of recurrence assessment, duration of follow-up, and principal recurrence outcome.

The review originated as a structured literature review and was subsequently revised to meet systematic-review reporting standards. Complete contemporaneous record-level screening counts from the initial search were not retained; consequently, retrospective numerical reconstruction of the original identification and exclusion stages was not undertaken. The study-selection figure therefore depicts the documented re-screening process and the final number of eligible primary studies.

Outcome definitions and synthesis

The primary outcome was postoperative hiatal or paraesophageal hernia recurrence. Short-term recurrence was defined as recurrence identified within 12 months when an explicit interval was reported.

Recurrence was recorded according to each study's stated definition and categorized by assessment method, including contrast esophagography, computed tomography, endoscopy, clinical symptoms, or composite follow-up.

Symptomatic and radiographic recurrence were not considered interchangeable. Because of substantial heterogeneity in hernia phenotype, mesh type, recurrence definition, and follow-up, findings were synthesized qualitatively rather than pooled in a new meta-analysis.

RESULTS

Study selection and characteristics

Eleven primary studies met the eligibility criteria and were included in the qualitative synthesis (Table 1). The evidence base comprised randomized trials, long-term follow-up of randomized cohorts, observational cohorts, and comparative studies of robotic and laparoscopic repair. Considerable clinical and methodological heterogeneity was present across studies, including differences in hernia phenotype and size, crural closure technique, reinforcement material, recurrence definition, surveillance modality, and duration of follow-up.

Mesh reinforcement and recurrence

Early randomized evidence suggested a possible short-term anatomic benefit from reinforcement. Frantzides et al reported fewer recurrences after PTFE reinforcement of large hiatal defects, and Oelschlager et al demonstrated lower six-month recurrence with biologic reinforcement in a multicenter randomized trial.[4,9] The durability of that benefit was less convincing. Long-term follow-up of the Oelschlager cohort showed similar recurrence with primary repair and biologic reinforcement, while subsequent randomized and comparative studies did not consistently demonstrate durable superiority of mesh over suture-only cruroplasty.[10-12,17-19] Broader literature reaches similarly cautious conclusion: meta-analyses may demonstrate lower early recurrence in selected mesh groups, but the certainty of durable benefit is limited, particularly when interpretation emphasizes randomized evidence and clinically meaningful outcomes.[20-24]

Robotic versus laparoscopic repair

Robotic repair has been reported as feasible with favorable outcomes in experienced centers. O'Connor et al reported lower recurrence in a retrospective robotic cohort, while Gerull et al described favorable perioperative outcomes with robotic approach. These findings remain vulnerable to selection, surgeon, and center effects.[13,14]

Population-level comparative data have also raised concerns regarding perioperative complications with robotic repair, and systematic review evidence has not demonstrated a reproducible clinical or recurrence advantage over conventional laparoscopy.[15,25]

Taken together, these data are insufficient to attribute a reduction in recurrence to the robotic platform itself. Case selection, surgeon and center experience, extent of mediastinal mobilization, tension at crural closure, reinforcement strategy, and intensity of postoperative surveillance represent important potential confounders in the available comparative literature.

Recurrence assessment

Recurrence ascertainment varied substantially. Protocolized barium esophagography, computed tomography, or endoscopy can detect asymptomatic anatomic recurrence that symptom-based follow-up will miss. Conversely, small radiographic recurrences may not represent clinically meaningful failure. This heterogeneity limits direct comparison of raw recurrence percentages across studies.

Table 1: Primary studies included in the qualitative synthesis.

Studies	Design	Approach	Mesh/ comparator	Assessment	Principal finding
Frantzides et al 2002[4]	Randomized trial	Laparoscopic	PTFE vs suture	Objective follow up	Lower recurrence with PTFE reinforcement in large defects.
Oelschlager et al 2006[9]	Multicenter randomized trial	Laparoscopic	Biologic SIS vs primary repair	6-mo UGI	Recurrence 9% with SIS vs 24% with primary repair.
Oelschlager et al 2011[10]	Long-term randomized follow-up	Laparoscopic	Biologic SIS vs primary repair	Median 58-mo UGI	Recurrence 54% vs 59%; early benefit not maintained.
Bell et al 2013[17]	Multicenter cohort	Laparoscopic	Allograft dermal matrix	Clinical/objective follow-up	Reported outcomes after biologic reinforcement.
Lidor et al 2015[18]	Prospective cohort	Laparoscopic	Biologic mesh buttress	1-y barium study	27% radiographic recurrence among patients completing imaging.
Tam et al 2017[19]	Retrospective comparative	Laparoscopic	Selective mesh vs no mesh	Radiographic follow-up	Recurrence similar: 22% mesh vs 17% no mesh.
Oor et al 2018[11]	Randomized trial	Laparoscopic	Nonabsorbable mesh vs suture	Barium/ endoscopy at 1 y	No significant recurrence difference.
Analatos et al 2020[12]	Randomized double-blind trial	Laparoscopic	PTFE mesh vs suture	Barium swallow	No recurrence reduction; more solid-food dysphagia with mesh.
Watson et al 2020[26]	Randomized 5-y follow-up	Laparoscopic	Suture vs absorbable vs nonabsorbable mesh	Barium/ endoscopy	No five-year recurrence advantage for mesh.

Continued.

Studies	Design	Approach	Mesh/ comparator	Assessment	Principal finding
O'Connor et al 2020[13]	Retrospective comparative	Robotic vs laparoscopic	Variable	Clinical/objective follow-up	Lower recurrence observed robotically; nonrandomized comparison
Gerull et al 2021[14]	Comparative cohort	Robotic vs laparoscopic	Variable	Perioperative/ clinical outcomes	Favorable robotic perioperative outcomes; recurrence evidence limited.

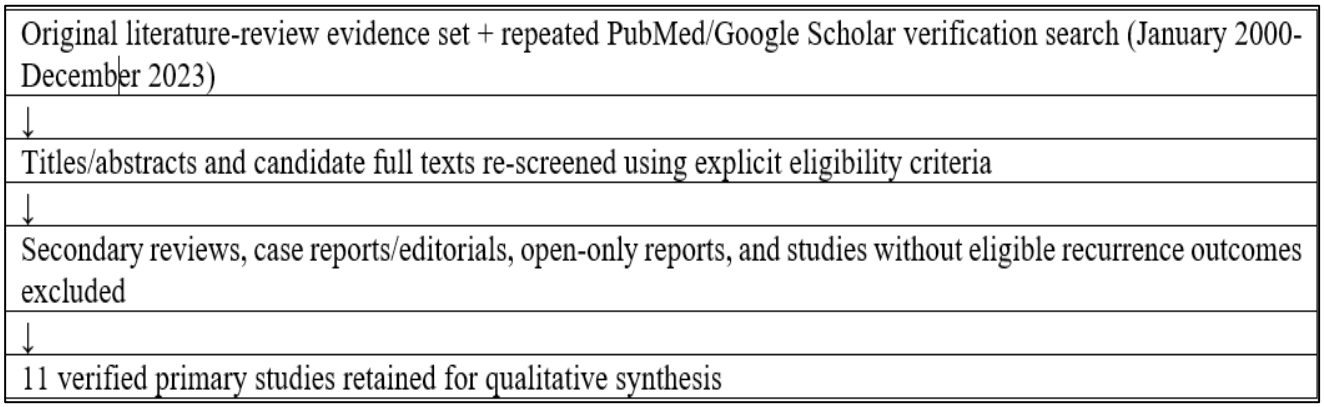

Figure 1: Study-selection pathway for the revised systematic review.

DISCUSSION

The principal finding of this systematic review is that mesh reinforcement may reduce early anatomic recurrence in selected hiatal hernia repairs, whereas evidence for a sustained long-term benefit remains inconsistent. Notably, the magnitude of benefit reported in several observational series is less apparent in randomized comparisons, and longer-term follow-up has attenuated differences observed during early postoperative surveillance. These findings argue against interpreting early radiographic recurrence alone as evidence for routine reinforcement.

This interpretation is consistent with prior evidence syntheses. Tam et al. found lower odds of objective recurrence after mesh cruroplasty but rated the evidence supporting routine mesh use as low. Subsequent meta-analyses and network meta-analyses have continued to demonstrate heterogeneity by study design, mesh material, and follow-up, with uncertainty regarding long-term clinical benefit.[20-24]

Interpretation of recurrence is further complicated by the distinction between anatomic and clinically meaningful failure. Protocolized imaging may identify small, asymptomatic recurrences that never require intervention, whereas symptom-driven surveillance can underestimate

anatomic recurrence. Accordingly, radiographic recurrence, symptomatic recurrence, reoperation, postoperative dysphagia, reflux control, and health-related quality of life should be reported as distinct outcomes.

Mesh-related morbidity must also be incorporated into the risk-benefit calculation. Although erosion is uncommon, published cases demonstrate that erosion or migration can produce substantial morbidity and occasionally require complex organ resection. Systematic review data likewise emphasize that mesh-specific complications, while infrequent, are clinically important.[6,7]

The available robotic literature should be interpreted in the same context. Although robotic systems may facilitate intracorporeal suturing and complex mediastinal dissection, recurrence is determined by multiple patient-, hernia, and technique-related factors. Adequacy of mediastinal mobilization, intra-abdominal esophageal length, tissue quality, hiatal defect size, tension at crural closure, reinforcement strategy, surgeon experience, and surveillance intensity may each influence measured durability. The predominantly retrospective nature of platform comparisons therefore limits causal inference regarding a recurrence advantage attributable to the robotics.

From a clinical perspective, the available evidence supports selective rather than routine reinforcement. Mesh may be considered when primary crural approximation is judged to be under substantial tension, tissue quality is compromised, or the hiatal defect is large; however, the anticipated reduction in recurrence must be balanced against mesh-specific morbidity and the potential complexity of future revisional surgery. The decision to reinforce the hiatus should therefore remain individualized and informed by patient characteristics, operative findings, mesh type, and surgeon experience.

Limitations

This review has several limitations. The search was restricted to PubMed and Google Scholar and to English-language publications, introducing the possibility of incomplete retrieval. Because the project originated as a literature review, complete contemporaneous record-level counts from the initial screening process were not retained; the revised review therefore used a documented re-screening process rather than retrospective reconstruction of unavailable historical counts. Substantial heterogeneity was present in hernia phenotype, operative technique, reinforcement material, recurrence definition, surveillance modality, and follow-up duration. In addition, robotic-specific recurrence evidence was limited and predominantly retrospective. Quantitative pooling was not performed because the available studies did not provide sufficiently homogeneous outcome definitions and follow-up intervals to support a clinically meaningful pooled estimate.

CONCLUSION

Available evidence suggests that mesh reinforcement may reduce early anatomic recurrence following minimally invasive hiatal hernia repair in selected patients; however, this benefit has not been consistently sustained with longer follow-up. Comparative evidence likewise remains insufficient to demonstrate a recurrence advantage of robotic over conventional laparoscopic repair. Given substantial heterogeneity in patient selection, reinforcement materials, recurrence definitions, and surveillance strategies, the current literature does not support routine mesh reinforcement or preferential use of either minimally invasive platform solely to reduce recurrence.

Prospective comparative studies incorporating standardized definitions of anatomic and symptomatic recurrence, objective surveillance, mesh-specific reporting, and long-term patient-centered outcomes are needed to identify the patients most likely to derive durable benefit from reinforcement.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Bursalyan D, Kim JC. Short-term recurrence following robotic versus laparoscopic hiatal hernia repair with and without mesh reinforcement: a systematic review. Int Surg J 2026;13:2530-5.