Title: SurgiPerito Trial: High-Purity Type-I Collagen for Peritoneal Reconstruction After Cytoreductive Surgery

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INTRODUCTION

Peritoneal surface malignancies (PSMs), arising from primary tumors such as colorectal carcinoma, ovarian cancer, appendiceal neoplasms, malignant peritoneal mesothelioma, and pseudomyxoma peritonei, represent a challenging oncologic condition associated with significant morbidity and historically poor survival outcomes. Over the last two decades, cytoreductive surgery (CRS), with or without hyperthermic intraperitoneal chemotherapy (HIPEC), has emerged as a standard-of-care strategy in selected patients, demonstrating improved overall and disease-free survival when complete cytoreduction is achieved [1–3].

CRS frequently necessitates extensive peritonectomy to remove macroscopic tumor deposits. While oncologically effective, peritonectomy disrupts the native peritoneal lining, a specialized mesothelial surface responsible for frictionless visceral movement, immunologic defense, fluid homeostasis, and rapid tissue repair [4]. Loss of this biological barrier predisposes patients to a spectrum of postoperative complications, including dense intra-abdominal adhesions, adhesive small bowel obstruction, prolonged postoperative ileus, enterocutaneous fistula formation, surgical site infection, incisional hernia, and the need for reoperation [5–7]. These complications significantly prolong hospital stay, delay adjuvant oncologic therapies, impair quality of life, and increase overall healthcare utilization.

At present, there is no universally accepted standard for peritoneal reconstruction following peritonectomy. Conventional surgical practice typically involves leaving the peritoneal defect untreated, allowing secondary healing through fibrosis. However, this process is often disorganized and pro-inflammatory, promoting excessive fibrin deposition and adhesion formation rather than structured regeneration of a functional mesothelial layer [8]. Consequently, there has been increasing interest in biologic materials that can serve as temporary peritoneal substitutes, restoring anatomic continuity while modulating the wound-healing response.

High-purity Type I collagen (HPTC)–based biomaterials have demonstrated favorable biological and mechanical properties across a range of reconstructive and regenerative surgical applications. Collagen, the principal structural protein of the extracellular matrix, plays a critical role in cellular adhesion, angiogenesis, and tissue remodeling. When processed through stringent purification protocols, HPTC scaffolds are biocompatible, minimally immunogenic, and bioresorbable, providing a three-dimensional framework that supports orderly tissue regeneration rather than scar-driven fibrosis [9–11].

In abdominal and reconstructive surgery, collagen-based matrices have been shown to reduce infection rates, improve integration in contaminated fields, and promote functional tissue repair. Prior studies evaluating biological meshes in the context of complex abdominal wall reconstruction during CRS have demonstrated acceptable safety profiles and encouraging clinical outcomes [12]. Additionally, emerging clinical evidence from wound care and soft tissue reconstruction has shown

that HPTC-based scaffolds can significantly reduce complication rates and enhance healing outcomes when compared with alternative biological substitutes [13–16].

Surgicoll-Mesh® is a sterile, resorbable, high-purity Type I collagen–based biomaterial designed to function as a temporary regenerative scaffold [17]. When used as a peritoneal substitute following peritonectomy, it is hypothesized to provide a protective barrier between visceral surfaces, reduce fibrin-mediated adhesion formation, and facilitate organized neo-peritoneal regeneration during the critical early postoperative period. Despite strong biological plausibility and supportive evidence from related surgical domains, high-quality prospective randomized data evaluating collagen-based peritoneal substitutes in patients undergoing CRS for intraperitoneal malignancy remain limited.

Given the substantial morbidity associated with post-peritonectomy complications and the absence of standardized reconstructive strategies, there exists a clear unmet clinical need for interventions that enhance intra-abdominal healing without compromising oncologic safety. This need is particularly relevant in resource-conscious healthcare systems, where reducing postoperative complications has direct implications for patient outcomes and system sustainability.

Accordingly, this prospective, multicenter, randomized controlled trial was designed to evaluate the safety and efficacy of Surgicoll-Mesh® as a peritoneal substitute following peritonectomy in patients undergoing CRS for intraperitoneal malignancies. The primary objective was to determine whether the use of a high-purity Type I collagen scaffold reduces the incidence of major postoperative intra-abdominal complications compared with standard peritonectomy closure. Secondary objectives included assessment of individual complication rates, bowel function recovery, length of hospital and intensive care stay, device-related adverse events, radiologic evidence of adhesions, and patient-reported quality of life outcomes using a validated instrument.

MATERIALS AND METHODS

Study Design and Setting

This study was designed as a prospective, multicenter, open-label, randomized controlled clinical trial evaluating the safety and efficacy of a high-purity Type I collagen–based biomaterial (Surgicoll-Mesh®) as a peritoneal substitute following peritonectomy in patients undergoing cytoreductive surgery (CRS) for intraperitoneal malignancies. The trial was conducted at two tertiary referral centers specializing in oncologic and reconstructive surgery.

The trial was conducted at two tertiary oncology referral centers – JSS Academy of Higher Education and Research, Mysuru and Adichunchangiri Institute of Medical Sciences, B G Nagara. The trial was registered prospectively with ClinicalTrials.gov (ID: NCT07241091) and approved by the Institutional Ethics Committee (Approval No.: AIMS/IEC/266/2025). The study was conducted in accordance with the principles of the Declaration of Helsinki, Good Clinical Practice (GCP) guidelines, and Consolidated Standards of Reporting Trials (CONSORT) recommendations [18].

Institutional Ethics Committee approval was obtained at all participating centers prior to patient enrollment.

Study Population

Patients were consecutively screened for eligibility during multidisciplinary tumor board evaluation at participating centers. Adults aged 18–75 years with histologically confirmed peritoneal surface malignancy (including colorectal, ovarian, appendiceal, pseudomyxoma peritonei, or malignant peritoneal mesothelioma) scheduled to undergo cytoreductive surgery with anticipated peritonectomy, with or without hyperthermic intraperitoneal chemotherapy, were considered eligible. Additional inclusion criteria included Eastern Cooperative Oncology Group (ECOG) performance status 0–2 [19], adequate hematologic, renal, and hepatic function, and ability to provide written informed consent.

Exclusion criteria comprised known hypersensitivity to collagen-based products, active intra-abdominal infection or uncontrolled sepsis, chronic immunosuppression or long-term systemic corticosteroid therapy, pregnancy or lactation, extensive small-bowel resection precluding safe reconstruction, and emergency surgery or bowel perforation at presentation.

Randomization and Allocation

Eligible patients were randomized in a 1:1 ratio to either the intervention group (HPTC peritoneal reconstruction) or the control group (standard peritonectomy closure). Randomization was performed using a computer-generated block randomization sequence with variable block sizes to ensure balanced group allocation across participating centers.

Allocation concealment was achieved using sealed, opaque envelopes opened intraoperatively after completion of cytoreduction and confirmation of peritoneal defect suitability. Due to the nature of the surgical intervention, blinding of the operating surgeon was not feasible. However, outcome assessors, radiologists evaluating imaging studies, and statisticians were blinded to treatment allocation wherever applicable.

Surgical Procedure and Intervention

Cytoreductive Surgery and Peritonectomy

All patients underwent CRS performed by experienced surgical oncologists following standardized institutional protocols. The goal of CRS was complete or near-complete macroscopic tumor clearance (CC-0 or CC-1 resection). Peritonectomy procedures were carried out as required based on disease distribution and included parietal and/or visceral peritoneal stripping.

The use of HIPEC was permitted and performed according to tumor-specific protocols but was evenly distributed between study arms.

Intervention Group: HPTC Peritoneal Reconstruction

In patients randomized to the intervention arm, peritoneal defects created following peritonectomy were reconstructed using HPTC (Surgicoll-Mesh®), a sterile, resorbable, high-purity Type I collagen scaffold. The mesh was tailored intraoperatively to match the dimensions of the peritoneal defect and secured using interrupted absorbable sutures to adjacent tissue margins prior to abdominal closure. The biomaterial was applied without tension and without overlap onto visceral organs.
The mesh was intended to function as a temporary biologic barrier and regenerative scaffold, facilitating organized tissue remodeling during the early postoperative period [9–11].

Control Group: Standard Peritonectomy Closure

Patients allocated to the control arm underwent standard peritonectomy closure without the use of any peritoneal substitute or biomaterial. Peritoneal defects were left untreated, allowing secondary healing according to standard institutional practice.

Postoperative Care and Follow-Up

Postoperative management protocols, including analgesia, antibiotic prophylaxis, early mobilization, and nutritional advancement, were standardized across centers. Nasogastric decompression was discontinued at the discretion of the treating team based on bowel function recovery.
Patients were followed for a minimum of two months postoperatively, with scheduled clinical assessments at discharge, 30 days, and 60 days. Imaging studies and quality-of-life assessments were performed according to protocol-defined timelines.

Outcome Measures

Primary Outcome

The primary outcome was the incidence of major intra-abdominal complications within two months following surgery. Major complications were predefined as:

- Adhesive small bowel obstruction requiring intervention
- Enterocutaneous fistula
- Reoperation for intra-abdominal complication
- Grade ≥3 wound complications based on the Clavien–Dindo classification

Secondary Outcomes

Secondary outcomes included:

- Individual complication rates, including intraperitoneal adhesions, bowel obstruction, surgical site infection, incisional hernia, and fistula formation

- Time to bowel function recovery, defined as the time to first flatus and tolerance of oral diet
- Length of intensive care unit (ICU) stay and total hospital stay
- Device-related adverse events, including infection, inflammatory reaction, or mesh-related complications
- Radiologic assessment of adhesions or obstruction using magnetic resonance imaging (MRI) at baseline, one month, and two months
- Quality of life assessment using the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30), a validated cancer-specific instrument [20]

Sample Size Calculation

Based on prior literature reporting postoperative complication rates of approximately 40–45% following extensive peritonectomy, a reduction to 15–20% in the intervention group was considered clinically meaningful. The required sample size for comparing two independent proportions was estimated using the formula:

$$n = ((Z1-\alpha/2 + Z1-\beta)^2 \times [p1(1-p1) + p2(1-p2)]) / (p1-p2)^2$$

where p_1 represents the expected complication rate in the control group and p_2 the expected rate in the intervention group, $Z_{1-\alpha/2}$ corresponds to the two-sided significance level $\alpha=0.05$, and $Z_{1-\beta}$ to the desired power (80%). Assuming $p_1=0.40$ and $p_2=0.20$, the calculated minimum sample size was 26 patients per group. To account for potential dropouts and protocol deviations, 30 patients were enrolled in each arm, yielding a total sample size of 60 participants.

Statistical Analysis Plan

Statistical analyses were performed using SPSS version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test and are presented as mean ± standard deviation for normally distributed data or median with interquartile range for non-normally distributed data. Between-group comparisons were conducted using the independent t-test or Mann–Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate. Effect estimates for the primary and key secondary binary outcomes were expressed as relative risks with 95% confidence intervals. Time-to-event outcomes, including time to bowel function recovery, were analyzed using Kaplan–Meier survival curves with log-rank testing. Multivariable logistic regression analysis was performed to adjust for potential confounders, including age, primary tumor type, peritoneal cancer index score, and use of hyperthermic intraperitoneal chemotherapy. All statistical tests were two-sided, and a p-value < 0.05 was considered statistically significant. Analyses were conducted on an intention-to-treat basis.

Data Management and Ethical Considerations

All data were prospectively collected using standardized case report forms and anonymized prior to analysis. Data integrity was ensured through regular monitoring and cross-verification. The study included a predefined plan for de-identified individual participant data (IPD) sharing upon reasonable request following publication.

REFERENCES

1. Sugarbaker PH. Cytoreductive surgery and perioperative intraperitoneal chemotherapy as a curative approach to pseudomyxoma peritonei syndrome. Tumori. 2001 Jul-Aug;87(4):S3-5. https://pubmed.ncbi.nlm.nih.gov/11693816/
2. Verwaal VJ, van Ruth S, de Bree E, van Sloothen GW, van Tinteren H, Boot H, Zoetmulder FA. Randomized trial of cytoreduction and hyperthermic intraperitoneal chemotherapy versus systemic chemotherapy and palliative surgery in patients with peritoneal carcinomatosis of colorectal cancer. J Clin Oncol. 2003 Oct 15;21(20):3737-43. doi: 10.1200/JCO.2003.04.187.
3. Chua TC, Moran BJ, Sugarbaker PH, Levine EA, Glehen O, Gilly FN, et al. Early- and long-term outcome data of patients with pseudomyxoma peritonei from appendiceal origin treated by a strategy of cytoreductive surgery and hyperthermic intraperitoneal chemotherapy. J Clin Oncol. 2012 Jul 10;30(20):2449-56. doi: 10.1200/JCO.2011.39.7166.
4. Mutsaers SE. Mesothelial cells: their structure, function and role in serosal repair. Respirology. 2002 Sep;7(3):171-91. doi: 10.1046/j.1440-1843.2002.00404.x.
5. Glockzin G, Schlitt HJ, Piso P. Peritoneal carcinomatosis: patients' selection, perioperative complications and quality of life related to cytoreductive surgery and hyperthermic intraperitoneal chemotherapy. World J Surg Oncol. 2009 Jan 8;7:5. doi: 10.1186/1477-7819-7-5.
6. Alberto Vilchez ME, Halskov S, Winter A, Pratschke J, Rau B, Gül S. Morbidity and Mortality after Cytoreductive Surgery and HIPEC in a National Reference Center: A Six-Year Experience under Independent Evaluation. J Clin Med. 2024 Aug 31;13(17):5182. doi: 10.3390/jcm13175182.
7. Chua TC, Yan TD, Saxena A, Morris DL. Should the treatment of peritoneal carcinomatosis by cytoreductive surgery and hyperthermic intraperitoneal chemotherapy still be regarded as a highly morbid procedure? A systematic review of morbidity and mortality. Ann Surg. 2009;249(6):900–907. doi: 10.1097/SLA.0b013e3181a45d86
8. Gere S. diZerega, Joseph D. Campeau, Peritoneal repair and post-surgical adhesion formation, Human Reproduction Update, Volume 7, Issue 6, 1 November 2001, Pages 547–555, doi: 10.1093/humupd/7.6.547
9. Shoulders MD, Raines RT. Collagen structure and stability. Annu Rev Biochem. 2009;78:929-58. doi: 10.1146/annurev.biochem.77.032207.120833.
10. Friess W. Collagen--biomaterial for drug delivery. Eur J Pharm Biopharm. 1998 Mar;45(2):113-36. doi: 10.1016/s0939-6411(98)00017-4.
11. Lynn AK, Yannas IV, Bonfield W. Antigenicity and immunogenicity of collagen. J Biomed Mater Res B Appl Biomater. 2004 Nov 15;71(2):343-54. doi: 10.1002/jbm.b.30096.

12. Tzivanakis A, Dayal SP, Arnold SJ, Mohamed F, Cecil TD, Venkatasubramaniam AK, Moran BJ. Biological mesh is a safe and effective method of abdominal wall reconstruction in cytoreductive surgery for peritoneal malignancy. BJS Open. 2018 Aug 2;2(6):464-469. doi: 10.1002/bjs5.93.
13. Narayan N, Gowda S, Shivannaiah C. A Randomized Controlled Clinical Trial Comparing the Use of High Purity Type-I Collagen-Based Skin Substitute vs. Dehydrated Human Amnion/Chorion Membrane in the Treatment of Diabetic Foot Ulcers. Cureus. 2024 Dec 5;16(12):e75182. doi: 10.7759/cureus.75182.
14. Narayan N, Shivannaiah C, Gowda S. Evaluating the Efficacy of High-Purity Type I Collagen-Based Skin Substitute Versus Dehydrated Human Amnion/Chorion Membrane in the Treatment of Venous Leg Ulcers: A Randomized Controlled Clinical Trial. Cureus. 2025 Jul 30;17(7):e89031. doi: 10.7759/cureus.89031.
15. Narayan N, Ramegowda YH, Raghupathi DS, Chethan S, Gowda S. Biological Skin Substitutes in Pressure Ulcers: High-Purity Type I Collagen-Based Versus Amnion/Chorion Membrane. Cureus. 2025 Aug 25;17(8):e90956. doi: 10.7759/cureus.90956.
16. Narayan N, Raghupathi D, Ramamurthy V, Chethan S, Gowda S. A Comparative Analysis in the Treatment of Full-Thickness Wounds: Negative-Pressure Wound Therapy (NPWT) Combined With High-Purity Type I Collagen-Based Skin Substitute Versus NPWT Alone. Cureus. 2025 Nov 16;17(11):e96977. doi: 10.7759/cureus.96977.
17. Advanced Biotech Products (P) Ltd. Surgicoll-Mesh®: implantable, bioresorbable tissue regenerative sterile type I collagen matrix [product information]. Chennai, India: Advanced Biotech Products; 2024. Available from: *https://www.advanced-biotech.com/surgicoll-mesh.html*
18. Schulz KF, Altman DG, Moher D. CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials. BMJ. 2010;340:c332. doi:10.1136/bmj.c332
19. Oken MM, Creech RH, Tormey DC, Horton J, Davis TE, McFadden ET, Carbone PP. Toxicity and response criteria of the Eastern Cooperative Oncology Group. Am J Clin Oncol. 1982 Dec;5(6):649–655.
20. Aaronson NK, Ahmedzai S, Bergman B, Bullinger M, Cull A, Duez NJ, Filiberti A, Flechtner H, Fleishman SB, de Haes JC, et al. The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst. 1993 Mar 3;85(5):365-76. doi: 10.1093/jnci/85.5.365.