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Re-evaluating the Need for Endostaplers in Laparoscopic Cystogastrostomy: A Comparative Analysis of Advanced Handsewn Technique in Resource-Conscious Settings.

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Abstract

Background: In state-funded tertiary healthcare systems, balancing clinical excellence with fiscal responsibility is paramount. Endoscopic linear cutting staplers simplify laparoscopic cystogastrostomy (LCG) for pancreatic pseudocysts (PPC), but disposable cartridge reloads incur significant institutional costs. ***Objective:*** To evaluate whether handsewn LCG executed by specialized gastrointestinal surgeons achieves equivalent clinical efficacy, safety, and long-term durability to endostapler-assisted LCG while delivering meaningful cost savings in public and safety-net healthcare settings. ***Methods:*** A multi-center, retrospective comparative cohort study of 48 consecutive patients undergoing LCG for mature pancreatic pseudocysts was conducted between April 2023 and March 2025 across three tertiary care centers in South India: Basaveshwar Teaching and General Hospital (MRMC, Kalaburagi), GIMS Super Speciality Hospital (Kalaburagi), and JSS Medical College (Mysuru). Patients were categorized into two cohorts based on intraoperative technique: Handsewn Group (n = 30): Performed using continuous or interrupted intracorporeal suturing. Stapled Group (n = 18): Performed using endoscopic linear cutting staplers. Outcome parameters evaluated included baseline clinical profiles, operative duration, intraoperative blood loss, anastomotic leakage, postoperative hemorrhage, length of hospital stay, 12-month recurrence rate, and direct institutional consumable hardware expenditure. ***Results:*** Demographics, baseline clinical characteristics, etiology, and cyst size (8.4 ± 1.8 cm vs. 8.2 ± 1.6 cm, p = 0.70) were well-balanced across both cohorts. Both groups demonstrated high success rates with zero 30-day perioperative mortality. Mean operative duration was moderately longer in the Handsewn Group (96.4 ± 12.8 min vs. 72.5 ± 10.2 min, p < 0.001). However, intraoperative blood loss (44.1 ± 11.5 mL vs. 41.8 ± 9.8 mL, p = 0.48), anastomotic leakage (1 [3.3%] vs. 1 [5.6%], p = 1.00), postoperative hemorrhage (0 [0.0%] vs. 1 [5.6%], p = 0.38), median length of hospital stay (4.0 days vs. 4.0 days, p = 0.65), and 12-month pseudocyst recurrence (1 [3.3%] vs. 0 [0.0%], p = 1.00) showed no statistically significant differences. Direct consumable equipment expenditure was drastically lower in the Handsewn Group (p < 0.001). ***Conclusion:*** When executed by surgeons proficient in advanced laparoscopy, handsewn LCG provides safety, hemostatic reliability, and long-term clinical outcomes equivalent to endostapler drainage at a fraction of the hardware cost. Advanced intracorporeal suturing expertise effectively eliminates reliance on expensive disposable devices in resource-conscious public healthcare facilities without compromising patient safety.

Keywords: Pancreatic pseudocyst, Laparoscopic cystogastrostomy, Handsewn cystogastrostomy, Stapled cystogastrostomy, Endoscopic linear stapler (Endo-GIA), Intracorporeal suturing.

INTRODUCTION

Pancreatic pseudocysts (PPC) represent a common local complication following acute or chronic pancreatitis, occurring in approximately 10–20% of acute pancreatitis episodes and up to 20–40% of chronic pancreatitis cases.[1,2] While small, asymptomatic, non-expanding fluid collections frequently undergo spontaneous resolution with conservative observation,[3,4] large (≥6 cm), symptomatic, infected, or progressive pseudocysts necessitate interventional drainage to relieve compressive symptoms and mitigate risks of rupture, hemorrhage, or gastric outlet obstruction.[3,4]

Historically managed via open surgery, internal drainage of pancreatic pseudocysts has undergone a major paradigm shift toward minimally invasive modalities.[5–8] Among these, laparoscopic cystogastrostomy (LCG) has established itself as a cornerstone approach.[7–11] LCG provides clear intraoperative visualization, flexible access to posterior gastric walls, reliable dependent drainage, and the unique surgical advantage of permitting extensive debridement and evacuation of thick intracystic necrotic debris—a technical limitation often encountered during purely endoscopic cystogastrostomy.[12,13]

In modern surgical practice, the introduction of endoscopic linear cutting staplers (Endo-GIA) has streamlined LCG by simplifying tissue approximation, facilitating rapid stoma creation, and shortening operative duration.[8,14,15] Consequently, mechanical stapled LCG has gained widespread popularity as the default technique. However, this reliance on disposable technology introduces a heavy financial burden.[16,17] In public and state-funded tertiary care hospitals across low- and middle-income countries (LMICs)—such as government medical colleges and subsidized safety-net teaching hospitals in India—healthcare is delivered free or heavily subsidized under strict budgetary constraints.[16–18] In these settings, high expenditure on single-use stapler handles and disposable cartridge reloads consumes a disproportionate share of operating theater budgets, directly limiting resources available for essential medical supplies, pharmaceuticals, and critical patient care services.[16–18]

Although international literature frequently cautions against handsewn LCG, citing the "steep learning curve" and technical complexity of two-handed intracorporeal suturing within a confined gastric lumen,[11,'19] this limitation reflects surgical training background rather than an inherent flaw in the technique. In specialized gastrointestinal surgery units where advanced laparoscopic expertise is well established,[19] intracorporeal handsewing can be performed safely, rapidly, and reproducibly.[21]

This multi-center study re-evaluates the necessity of routine endostapler deployment during LCG by comparing baseline clinical profiles, operative performance, safety parameters, long-term 12-month durability, and institutional consumable costs between handsewn and stapled techniques in resource-conscious public tertiary care hospitals.

MATERIALS AND METHODS

Study Design and Setting

This was a multi-center, retrospective comparative cohort study conducted jointly across the Surgical Gastroenterology units at three public and teaching tertiary institutions in Karnataka, South India:

1. Basaveshwar Teaching and General Hospital attached to M.R. Medical College, Kalaburagi, Karnataka, India.
2. Department of Surgical Gastroenterology, Gulbarga Institute of Medical Sciences – Super Speciality Hospital (GIMS-SSH), Kalaburagi, Karnataka, India.
3. Department of Surgical Gastroenterology, JSS Medical College, Mysuru, Karnataka, India.
4. The study evaluated all consecutive medical records of patients who underwent laparoscopic cystogastrostomy for mature pancreatic pseudocysts between April 2023 and March 2025.

Patient Selection and Eligibility

Patient records were identified through institutional electronic medical databases and operating room logs across the participating centers.

Inclusion Criteria:

- Adult patients aged 18–65 years.
- Symptomatic, mature, walled-off pancreatic pseudocysts (≥ 6 cm) in maximum cross-sectional diameter confirmed on non-contrast and contrast-enhanced computed tomography (CECT) of the abdomen with ≥ 6 weeks of maturation time.
- Clear anatomical apposition between the anterior wall of the pseudocyst and the posterior wall of the stomach on imaging.

Exclusion Criteria:

- Pseudoaneurysms within or immediately adjacent to the pseudocyst wall on arterial-phase CT angiogram.
- Suspicion of cystic neoplasms of the pancreas (e.g., mucinous cystic neoplasm, intraductal papillary mucinous neoplasm [IPMN]) based on imaging or aspirated cyst fluid chemistry (CEA, amylase).
- Uncorrected coagulopathy or severe liver cirrhosis (Child-Pugh Class C).
- Severe host physiological compromise precluding general anesthesia or carbon dioxide pneumoperitoneum (ASA Class ≥ IV).
- Prior upper abdominal open surgery precluding safe laparoscopic access.

Allocation and Selection Bias Mitigation

Surgical approach selection (handsewn vs. stapled) was non-randomized and was determined by attending surgeon preference, real-time availability of endostapler hardware/reloads in supply inventories, and patient choice/financial capacity regarding private hardware procurement.

To mitigate inherent selection bias stemming from non-randomized allocation, all participating centers strictly adhered to standardized surgical protocols and perioperative care pathways. Consecutive sampling was implemented, and baseline demographic and clinical comparability between cohorts was verified statistically before evaluating primary outcomes.

Informed Consent

Prior to surgical procedures, standard written informed consent for laparoscopic surgery, intraoperative conversions, and anonymized academic data utilization was obtained from all participants or their legal guardians.

Surgical Technique

All surgical procedures were conducted under general anesthesia with endotracheal intubation. Patients were placed in a modified split-leg reverse Trendelenburg position (30° incline) with the primary operating surgeon standing between the patient's legs. Pneumoperitoneum (12 mmHg) was established using a open Hasson or optical entry technique at the umbilicus. A standard four-port arrangement was used: a 10-mm camera port at the umbilicus, one 10/12-mm working port in the right upper quadrant, one 5-mm working port in the left upper quadrant, and a 5-mm epigastric port for liver retraction.

1. Cyst Identification and Localization: The stomach was insufflated via a nasogastric tube to delineate anatomy. The prominent bulge of the pseudocyst along the posterior wall of the stomach was identified visually. Intraoperative needle aspiration using a 21-gauge laparoscopic needle confirmed cyst contents, localized the center of the cavity, and ruled out vascular structures.
2. Anterior Gastrotomy: A 3–4 cm longitudinal anterior gastrotomy was created on the anterior body/antrum of the stomach using ultrasonic energy or monopolar electrocautery, allowing direct visualization of the posterior gastric wall and the bulging pseudocyst.
3. Cystogastrostomy Creation:

• Handsewn Group (n = 30): A matching 3–4 cm longitudinal cystotomy was performed through the posterior gastric wall into the pseudocyst cavity. Fluid was evacuated via high-capacity suction, and intracystic necrotic debris was removed using non-traumatic graspers. An anastomotic stoma was created using continuous or interrupted 2-0 / 3-0 absorbable (e.g., Polyglactin 910) or non-absorbable (e.g., Polypropylene) sutures. Full-thickness tissue bites incorporating posterior gastric mucosa, submucosa, muscularis, and the fibrous pseudocyst wall were taken to achieve compression and hemostasis.

• Stapled Group (n = 18): A small 1-cm puncture was made through the posterior gastric wall into the cyst cavity. An endoscopic linear cutting stapler (Endo-GIA, 45 mm or 60 mm vascular/medium cartridge reload) was introduced through the 12-mm trocar. One jaw was placed into the pseudocyst cavity and the other into the gastric lumen. The stapler was closed and fired. A second firing was performed if necessary to achieve an anastomotic opening ≥ 3 cm). The staple line was inspected for hemorrhage; hemostatic clips or suture underscoring were applied if bleeding occurred.

1. Gastrotomy Closure & Completion: In both cohorts, the anterior gastrotomy was closed in two layers (inner continuous mucosal/submucosal layer and outer seromuscular layer) using 3-0 Vicryl/Barbed intracorporeal suturing. Irrigation of the peritoneal cavity was performed, and a closed-suction intraperitoneal drain was placed near the anterior gastrotomy site at the operating surgeon's discretion.

Outcome Measures

• **Primary Outcomes:** Total operative duration (from skin incision to port closure, minutes), estimated intraoperative blood loss (calculated via suction canister volume minus irrigation volume plus sponge weight, mL).

• **Secondary Outcomes:** Early postoperative complications including anastomotic leak (defined as bilious, purulent, or amylase-rich drain output > 3 times upper normal limit of serum amylase after postoperative day 3), postoperative hemorrhage (gastrointestinal bleeding requiring transfusion or re-intervention), length of hospital stay (days), and 12-month pseudocyst recurrence rate evaluated via follow-up clinical examination and abdominal ultrasound/CT imaging at 1, 3, 6, and 12 months postoperatively.

Statistical Analysis

Statistical analysis was performed using SPSS Statistics for Windows, Version 28.0. Continuous variables were assessed for distributional normality using the Shapiro-Wilk test. Continuous data following a normal distribution were expressed as Mean ± Standard Deviation (SD) and compared between cohorts using the independent Student's t-test. Non-normally

distributed continuous variables were expressed as Median with Interquartile Range (IQR) and compared using the Mann-Whitney U test.

Categorical variables were presented as absolute numbers and percentages (n, [%]) and evaluated using Pearson's chi-square test or Fisher's exact test when expected cell counts were < 5. All statistical tests were two-tailed, and a p-value < 0.05 was considered statistically significant.

RESULTS

Baseline Demographics and Clinical Characteristics

A total of 48 patients met all eligibility criteria and underwent LCG across the three participating institutions during the 24-month study period (n = 30 in the Handsewn Group; n = 18 in the Stapled Group). Baseline patient characteristics—including age, sex, BMI, etiology of pancreatitis, mean pseudocyst diameter, and pre-procedure symptom duration—were comparable between the two cohorts with no statistically significant differences (Table 1).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (N = 48)

Parameter	Handsewn Group (n=30)	Stapled Group (n=18)	Test Statistic (t / χ^2)	p-value
Age (years), Mean ± SD	42.6 ± 10.4	44.1 ± 9.8	t = -0.49	0.62
Sex (Male / Female), n (%)	22(73.3%) / 8(26.7%)	14(77.8%) / 4(22.2%)	χ^2 = 0.12	0.73
BMI, Mean ± SD	22.8 ± 3.1	23.4 ± 2.9	t = -0.66	0.51
Etiology of Pancreatitis, n (%)			χ^2= 0.41	0.81
* Alcohol-induced	18(60.0%)	12(66.7%)		
* Gallstone-disease	9(30.0%)	5(27.8%)		
* Post-Traumatic / Idiopathic	3(10.0%)	1(5.6%)		
Mean Pseudocyst Size (cm), Mean ± SD	8.4 ± 1.8	8.2 ± 1.6	t = 0.39	0.70
Symptom Duration (weeks), Median (IQR)	8.5(7.0-11.0)	9.0(7.0-12.0)	U = 252.5	0.72
ASA Physical Status (I / II / III), n (%)	12/ 15/ 3	7/ 9/ 2	χ^2 = 0.08	0.96

Intraoperative and Postoperative Outcomes

Table 2: Primary and Secondary Perioperative Outcomes

Outcome Parameter	Handsewn Group (n=30)	Stapled Group (n=18)	Effect Estimate / Difference	p-value
Mean Operative Time (min), Mean ± SD	96.4 ± 12.8	72.5 ± 10.2	+23.9 min	< 0.001
Estimated Blood Loss (mL), Mean ± SD	44.1 ± 11.5	41.8 ± 9.8	+2.3 mL	0.48
Anastomotic Leakage, n (%)	1(3.3%)	1(5.6%)	OR = 0.59(0.03-10.1)	1.00
Postoperative Hemorrhage, n (%)	0(0.0%)	1(5.6%)	Risk Diff = -5.6%	0.38
Surgical Site Infection (SSI), n (%)	2(6.7%)	1(5.6%)	OR = 1.21(0.10-14.3)	1.00
Median Length of Stay (days), Median (IQR)	4.0(3.0-5.0)	4.0(3.0-5.0)	Diff = 0 days	0.65
12-Month Recurrence, n (%)	1(3.3%)	0(0.0%)	Risk Diff = +3.3%	1.00
30-Day Perioperative Mortality, n (%)	0(0.0%)	0(0.0%)	-	-

Operative Duration & Hemostasis

The mean operative duration was significantly longer in the Handsewn Group compared to the Stapled Group (96.4 ± 12.8 min vs. 72.5 ± 10.2 min, p < 0.001), representing an average time difference of 23.9 minutes attributable to the technical time required for placing intracorporeal sutures. However, this extra operative time did not lead to increased intraoperative blood loss (44.1 ± 11.5 mL vs. 41.8 ± 9.8 mL, p = 0.48) or higher rates of anesthetic complications.

Postoperative staple-line/suture-line hemorrhage occurred in 0 patients (0.0%) in the Handsewn Group and 1 patient (5.6%) in the Stapled Group (p = 0.38). The single bleeding event in the Stapled Group manifested as self-limiting melena on

postoperative day 2, which was successfully managed conservatively with blood transfusion and proton pump inhibitor infusion without requiring re-operation. Full-thickness suturing in the handsewn group provided reliable primary hemostasis along the hypervascular margins of the inflamed gastric and cyst walls.

Complications & 12-Month Follow-up

Overall morbidity was low across both cohorts. Minor anastomotic leakage occurred in 1 patient in the Handsewn Group (3.3%) and 1 patient in the Stapled Group (5.6%) (p = 1.00). Both cases presented with low-volume, amylase-rich drainage and were managed non-operatively via continued suction drainage and oral bowel rest; both resolved within 10 days without requiring secondary intervention. Length of hospital stay was identical between the two groups (median 4.0 days, p = 0.65).

All 48 patients completed the prospective 12-month clinical and radiological follow-up protocol. At 12 months, complete resolution of the pseudocyst was confirmed in 97.9% of the total cohort. Pseudocyst recurrence occurred in 1 patient (3.3%) in the Handsewn Group at 8 months postoperatively, secondary to an episode of recurrent alcohol-induced acute pancreatitis. The overall 12-month recurrence rates showed no statistically significant difference between groups (3.3% vs. 0.0%, p = 1.00).

Institutional Consumable Expenditure

Direct consumable hardware costs were significantly lower in the Handsewn Group compared to the Stapled Group.[16,17] The use of handsewn intracorporeal suturing resulted in an average cost reduction of approximately 40,000 INR per procedure, representing a >95% reduction in consumable equipment overhead.[16]

DISCUSSION

Internal drainage remains the definitive gold-standard management for mature, symptomatic pancreatic pseudocysts.[3,4] While endoscopic ultrasound (EUS)-guided cystogastrostomy using lumen-apposing metal stents (LAMS) has expanded rapidly in private academic centers,[4,13] laparoscopic cystogastrostomy (LCG) retains distinct advantages in resource-constrained public healthcare systems.[6,7,9,20] LCG allows direct evacuation of extensive necrotic debris, provides wide and durable surgical stoma creation, and carries lower device-related recurring costs.[9,10,17]

Mechanical endostaplers have gained widespread popularity in minimally invasive surgery due to their convenience and speed.[8,14] However, our multi-center findings demonstrate that handsewn laparoscopic cystogastrostomy performed by dedicated gastrointestinal surgeons achieves equivalent safety, hemostasis, and 12-month clinical effectiveness while offering significant cost advantages.16,18,21

Overcoming the "Steep Learning Curve" Argument

Surgical literature often cautions against handsewn LCG, highlighting the steep learning curve required for intracorporeal suturing within a confined gastric space.[11,19] While this learning curve is real for novice trainees, it represents an institutional training factor rather than a flaw in the technique itself.[19] In specialized gastrointestinal surgical units—surgeons routinely perform advanced intracorporeal suturing for bariatric, hepatobiliary, and foregut procedures.[19] Once technical proficiency is established, handsewn anastomoses offer notable structural advantages.[21] Thickened, chronic, inflamed pseudocyst walls can vary significantly in depth and tissue compliance. Fixed-height mechanical staples (e.g., 1.5 mm or 1.8 mm) may inadequately compress severely edematous tissues, increasing the risk of staple-line bleeding or incomplete tissue fusion. Conversely, handsewn suturing allows surgeons to tailor needle depth, adjust tension on each stitch, and incorporate full-thickness tissue bites across both the stomach and cyst walls, ensuring robust suture-line hemostasis.[21] This is reflected in our cohort, where zero postoperative bleeding events occurred in the handsewn group.

Economic Sustainability in Public Healthcare

In public and state-funded tertiary care institutions across LMICs, operating budgets are limited.[16–18] In these environments, spending several hundred dollars per patient on disposable stapler handles and reload cartridges imposes a substantial financial burden.[16,17]

By utilizing advanced intracorporeal suturing, our participating units reduced direct hardware consumable expenditure from ~ 42,000 INR to ~ 2,000 INR per case. In safety-net hospital systems, accumulating these individual savings across surgical lists allows institutions to reallocate funds toward vital pharmaceuticals, intensive care support, and expanded surgical access for underprivileged patient populations without compromising clinical quality.16,18,23

Technical and Anatomical Flexibility

Endoscopic linear cutters are constrained by rigid shafts and fixed cartridge lengths (45 mm or 60 mm). Inserting a rigid stapler through a posterior gastrotomy can sometimes be technically challenging depending on the pseudocyst's location relative to the posterior gastric wall.

In contrast, handsewn anastomoses allow surgeons to custom-tailor the length, orientation, and shape of the cystogastrostomy stoma to match the unique geometry of the pseudocyst. This technical flexibility helps ensure wide, dependent drainage even in anatomically challenging or eccentric pseudocysts.

STUDY LIMITATIONS

While this multi-center study provides practical clinical data from public healthcare settings, several limitations should be considered:

1. Non-Randomized Retrospective Design & Selection Bias: Allocation to the handsewn or stapled cohort was non-randomized and influenced by surgeon preference, patient choices, and local hardware availability. Although baseline clinical characteristics were comparable between groups, unmeasured confounding variables cannot be completely ruled out. Future studies should utilize prospective randomized controlled trials (RCTs)[9],[10] or apply propensity score matching (PSM) in larger cohorts to minimize selection bias.
2. Sample Size: The total cohort size (N = 48) was constrained by the strict inclusion criteria for mature pseudocysts requiring surgical intervention. While adequate for detecting major cost and operative duration differences, the study was underpowered to detect small differences in rare adverse events such as leaks or mortality.
3. Follow-Up Duration and Functional Outcomes: Although our 12-month follow-up period confirmed pseudocyst resolution and low recurrence rates, long-term monitoring (≥ 3-5 years) is needed to assess late stomal stenosis, pancreatic exocrine/endocrine function, and chronic pancreatitis progression.
4. Surgical Skill and Generalizability: All procedures were performed by board-certified gastrointestinal surgical specialists experienced in advanced minimally invasive surgery. These operative times, low complication rates, and cost advantages may not immediately generalize to low-volume community centers or general surgeons without dedicated intracorporeal suturing training.[19].

CONCLUSION

1. Handsewn laparoscopic cystogastrostomy performed by experienced GI surgeons achieves safety, low complication rates, and 12-month success rates equivalent to endostapler-assisted drainage.
2. Handsewn LCG eliminates the high cost of disposable stapling hardware, making it an ideal, cost-effective approach for public safety-net hospitals and resource-conscious healthcare systems.
3. Rather than relying on expensive single-use devices to bypass technical challenges, public healthcare institutions should invest in advanced laparoscopic suturing training for surgical teams. This approach reduces overall healthcare costs while maintaining high quality patient care.

Ethical Approval & Institutional Review:

The study protocol was reviewed and approved by the Institutional Ethics Committees (IEC) of the participating centers. All procedures performed involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments.

Informed Consent:

Standard written informed consent was obtained from all individual participants or legal guardians prior to surgical intervention, including authorization for anonymized data publication for academic purposes.

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Conflicts of Interest:

The authors declare that they have no competing financial interests, personal relationships, or commercial associations that could have influenced the work reported in this paper.

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