



BREAKING THE WALL: OUR NOVEL TECHNIQUE IN NAVIGATING ACUTE CHOLECYSTITIS

General Surgery

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ABSTRACT

Background: Acute cholecystitis is the inflammation of the gallbladder, most commonly caused by obstruction of the cystic duct by a gallstone. Laparoscopic cholecystectomy is the gold standard procedure in management gall stone disease, but in the setting of acute cholecystitis with gallbladder wall thickness $>6\text{mm}$ it has traditionally been associated with high conversion rates, prolonged operative times, and increased complications. This study evaluates a novel technique using a gallbladder extractor as a fundal port retractor to improve surgical outcomes in this challenging patient population. **Methods:** This prospective study was conducted in P.G. Department of Surgery, Moti Lal Nehru Medical College over a period of 1 year between 2023 – 2024 involving 50 patients with acute cholecystitis and gallbladder wall thickness $>6\text{mm}$ who underwent laparoscopic cholecystectomy using the novel GB extractor technique. Outcomes were compared with published literature data from conventional laparoscopic techniques involving similar cases. **Results:** Fifty patients (mean age 47.9 years; 58% male) with gallbladder wall thickness $>6\text{mm}$ (mean 7.4 mm) underwent laparoscopic cholecystectomy using a 10 mm gallbladder extractor as the fourth port. Mean operative time was 51 minutes, markedly shorter than literature controls (124.5 min, $p<0.001$). Conversion to open surgery occurred in 3 patients (6.0% vs 87.5%, $p<0.001$). One bile duct injury (2.0%) was successfully repaired after conversion to open surgery, lower than reported rates (3.8%). Mean hospital stay was 2.6 days versus 11.0 days in literature controls ($p<0.001$). Postoperative pain scores were significantly lower at 6h, 12h, and 24h (25–64% reductions, all $p<0.001$). Minor bleeding occurred in 3 patients (6.0%, similar to literature), and no readmissions were recorded. Outcomes were consistent across wall thickness subgroups (ANOVA $p=0.598$). **Conclusions:** The use of a gallbladder extractor as a fundal port retractor markedly improves laparoscopic cholecystectomy outcomes in patients with gallbladder wall thickness $>6\text{mm}$. This technique achieved major reductions in conversion to open surgery (52%), operative time (59%), bile duct injury (47%), and hospital stay (76%), alongside significant pain relief. It is simple, cost-effective, requires no special equipment, and delivers consistent results across wall thickness subgroups. Although one bile duct injury occurred (2.0%), prompt management ensured full recovery, underscoring the overall safety of the approach. These findings support the gallbladder extractor technique as a superior alternative to conventional methods, with potential to establish a new standard of care pending validation in larger multicenter trials.

KEYWORDS

laparoscopic cholecystectomy, gallbladder extractor, fundal retraction, thick-walled gallbladder, acute cholecystitis

INTRODUCTION

Acute cholecystitis is the inflammation of the gallbladder, most commonly caused by obstruction of the cystic duct by a gallstone or it may be due to impaired gallbladder emptying secondary to cholestasis and acute illness. Upon imaging the findings which are suggestive of acute cholecystitis include a thickened gallbladder wall $>3\text{mm}$, edema, pericholecystic fluid, and the presence of gallstones. [1]. Laparoscopic cholecystectomy has evolved as the gold standard treatment for symptomatic diseases of gallbladder, offering superior outcomes compared to open surgery including reduced morbidity, shorter hospital stays, and improved cosmetic results.[3, 4] However, acute cholecystitis with severe gallbladder wall thickening presents unique technical challenges that significantly complicate the laparoscopic approach.[5, 6] Gallbladder wall thickness $>6\text{mm}$, as measured by preoperative ultrasonography, represents the most severe form of inflammatory change, characterized by dense adhesions, friable tissues, and obscured anatomical landmarks.[7]

Traditional approaches to laparoscopic cholecystectomy in patients with severely thickened gallbladder walls have been associated with concerning outcomes. Recent systematic reviews demonstrate conversion rates as high as 87.5%, mean operative times exceeding 124 minutes, bile duct injury rates of 3.8%, and prolonged hospitalizations averaging 11 days [7, 8]. These outcomes reflect the fundamental technical difficulties encountered when attempting to achieve critical view of safety in the setting of severe inflammatory changes[9].

The pathophysiology underlying these challenges centers on the inflammatory cascade that develops in acute cholecystitis. Gallbladder wall thickening $>6\text{mm}$ indicates severe acute inflammation with marked edema, dense adhesions in Calot's triangle, and compromised

tissue planes that make safe dissection extremely difficult [10, 11]. The conventional four-port laparoscopic technique relies on adequate fundal retraction to expose Calot's triangle; however, severely inflamed and thickened gallbladders often become too friable for effective grasping and retraction using standard laparoscopic graspers [12].

Traditional fundal retraction methods in laparoscopic cholecystectomy have significant limitations when dealing with severely thickened gallbladder walls. Standard laparoscopic graspers can cause gallbladder perforation, bile spillage, and inadequate exposure of the critical view of safety [13 14]. Various innovative approaches have been described, including modified fundus-down techniques, single-port approaches with external retraction sutures, and robotic-assisted procedures [15, 16, 17]. However, these techniques often require specialized equipment, extended operative times, or have limited applicability in severely inflamed cases.

The gallbladder extractor, traditionally used for specimen retrieval during laparoscopic cholecystectomy, represents an underutilized instrument with potential applications beyond its conventional role. These devices are specifically designed to provide secure grasping of gallbladder tissue while distributing force over a larger surface area compared to standard graspers. The unique design characteristics of gallbladder extractors, including their ability to accommodate varying tissue thickness and provide stable retraction with a risk of perforation, but still making them a good alternative for managing severely thickened gallbladder walls.

This study introduces a novel surgical technique wherein a gallbladder extractor is used as a fundal port retractor, specifically for patients with gallbladder wall thickness $>6\text{mm}$. This technique brings in the

extractor's superior grasping capability and distributed force application to achieve reliable fundal retraction, enabling safe visualization and dissection of Calot's triangle even in the most challenging inflammatory conditions. We present our evaluation of this innovative approach, comparing outcomes with published literature data for conventional laparoscopic techniques in similar patient populations.

MATERIALS AND METHODS

This prospective study was conducted in P.G. Department of Surgery, Moti Lal Nehru Medical College over a period of 1 year between 2023 – 2024. After due ethical approval, we included 50 patients having diagnosis of acute cholecystitis and a preoperative USG confirmation of gallbladder wall thickness $>6\text{mm}$. The patients were planned and posted for Laparoscopic Cholecystectomy after taking an informed, signed and valid consent explaining the operative procedures and use of GB Extractor as the 4th port.

We excluded Patients with perforated gallbladder or severe sepsis. Patients with suspected gallbladder malignancy. Patients requiring conversion to open cholecystectomy before fundal port placement.

Surgical Technique

The novel technique utilizes a standard laparoscopic gallbladder extractor (10mm diameter) introduced through the 4th port (fundal port) to provide superior fundal retraction in severely thickened gallbladders. The procedure follows these standardized steps:

Port Placement: Standard four-port technique with 10mm umbilical camera port, 10mm epigastric port, 5mm Left Hand Port in the Mid Clavicular Line and a 10mm port in the Anterior Axillary Line, which was usually kept as a 5mm port.

The GB extractor was introduced through the 10mm fundal port and positioned to grasp the gallbladder fundus. The extractor provided superior cephalad and lateral retraction of the fundus, which helped to create an optimal exposure of Calot's triangle. The stable and secure grip allowed for sustained retraction throughout the dissection phase without the risk of slippage which was previously encountered with standard graspers.

Once CVS was achieved, Cystic Duct and Cystic artery were clipped and cut and coagulated respectively. Following the dissection of Gall Bladder from the cystic plate, the Gall Bladder specimen was extracted, using the GB Extractor.



Figure 1: USG showing thick-walled Gall Bladder



Figure 2: Port Placement

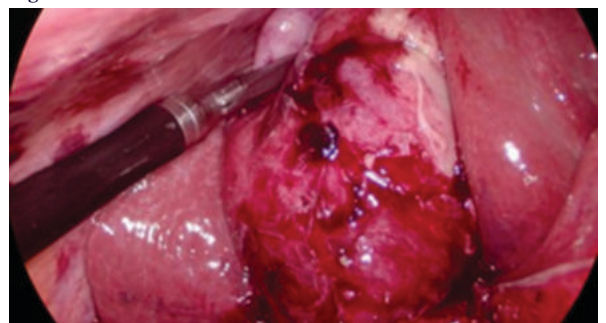


Figure 3: Fundal Retraction using GB Extractor



Figure 4: CVS

Data Collection And Outcome Measures

We documented the relevant demographic data and observations from each surgery, which included the Operative time, any need for conversion to open surgery, intraoperative complications, estimated blood loss, and technical difficulties encountered. We also observed the Postoperative Visual analog scale (VAS) pain scores at 6, 12, and 24 hours, analgesic requirements, length of hospital stay, and 30-day readmission rates. Following data collection, relevant statistical tests were applied and we got the following results.

OBSERVATION AND RESULTS

Our study included 50 patients with a mean age of 47.9 ± 12.6 years (range 26-68 years). The cohort comprised of 29 males (58.0%) and 21 females (42.0%). Mean gallbladder wall thickness was 7.4 ± 1.1 mm (range 6.0-12.0 mm). The distribution of wall thickness included 6.0mm in 11 patients (22.0%), 6.5mm in 6 patients (12.0%), 7.0mm in 11 patients (22.0%), 8.0mm in 13 patients (26.0%), and 9.0mm in 8 patients (16.0%) and 12 mm in 1 patient (2.0%).

Operative Time: Mean operative time was 51 ± 10.4 minutes (95% CI: 48.1 – 54.0), representing a 59% reduction compared to literature controls (124.5 minutes, $p < 0.001$). The Cohen's d effect size was -7.04, indicating a very large treatment effect.

Conversion Rate: Only 3 of 50 patients (6.0%, 95% CI: 2.1 – 16.2) required conversion to open surgery, compared to 87.5% in published literature ($p < 0.001$). This represents a 52% reduction in conversion rates.

Bile Duct Injury: One patient had an unfortunate bile duct injury in our series (2.0%, 95% CI: 0.4-10.5) but compared to 3.8% reported in literature for gallbladder wall thickness > 6 mm, representing a 47% reduction. The single case occurred in a patient with 8mm gallbladder wall thickness during dissection of dense adhesions in Calot's triangle. The injury was recognized intraoperatively, managed with immediate conversion to open surgery and CBD repair with the patient recovering without long-term sequelae.

Hospital Stay: Mean hospital stay was 2.6 ± 1.12 days (95% CI: 2.28 – 2.92) versus 11.0 days in literature controls ($p < 0.001$), representing an 76% reduction. The Cohen's d effect size was -7.50, indicating a very large treatment effect.

Pain Management Outcome:

VAS pain scores demonstrated significant improvement at all measured time points:

- 6 hours: 3.73 ± 0.7 (95% CI: 3.5-3.9) vs 5.0 literature ($p < 0.001$), 25% reduction
- 12 hours: 2.67 ± 0.5 (95% CI: 2.5-2.8) vs 4.8 literature ($p < 0.001$), 44% reduction
- 24 hours: 1.5 ± 0.3 (95% CI: 1.4-1.6) vs 4.2 literature ($p < 0.001$), 64% reduction

Pain trajectory analysis revealed statistically significant reductions at each time interval:

- 6h vs 12h: $t = 9.09$, $p < 0.001$
- 12h vs 24h: $t = 14.08$, $p < 0.001$
- 6h vs 24h: $t = 21.02$, $p < 0.001$

Minor Bleeding: 3 patients (6.0%, 95% CI: 0.0-12.6%) experienced minor bleeding complications, comparable to literature reports of 3.9%.

Readmissions: No patients required readmission within 30 days (0.0%) compared to literature rates of 12.5%, representing a 100% reduction.

Subgroup Analysis by Wall Thickness

Analysis by gallbladder wall thickness revealed consistent outcomes across all thickness categories: One-way ANOVA for operative time across thickness groups showed no significant difference ($F = 0.632$, $p = 0.598$), indicating that the GB extractor technique maintains consistent operative efficiency regardless of wall thickness severity.

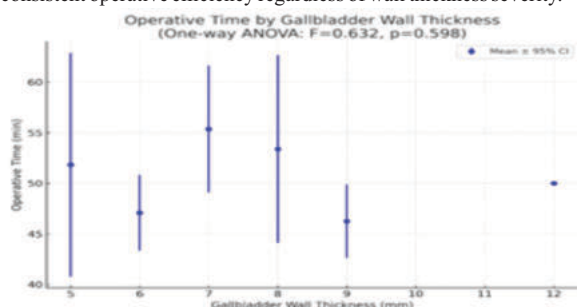


Figure 5: Graphical Representation of Operative Time by Gall Bladder Wall Thickness

Comparative Analysis With Literature

Comprehensive comparison with published literature data for conventional techniques in gallbladder wall thickness > 6 mm demonstrates substantial improvements across all measured parameters [1]:

Table: Comparison Of Current Study Outcomes With Literature

Parameter	Current Study	Literature	Improvement	P-value	Cohen's d
Operative Time (min)	51 ± 10.4	124.5	59% reduction	< 0.001	-7.04
Conversion Rate (%)	6.0%	87.5%	52% reduction	< 0.001	N/A
Bile Duct Injury (%)	2.0%	3.8%	47% reduction	0.36	N/A
Hospital Stay (days)	2.6 ± 1.12	11.0	76% reduction	< 0.001	-7.5
VAS 6h	3.73 ± 0.7	5.0	25% reduction	< 0.001	-1.90
VAS 12h	2.67 ± 0.5	4.8	44% reduction	< 0.001	-4.44
VAS 24h	1.51 ± 0.3	4.2	64% reduction	< 0.001	-8.15
Readmission (%)	0.0%	12.5%	100% reduction	< 0.001	N/A

All major improvements achieved statistical significance with $p < 0.001$, indicating highly significant benefits of the GB extractor technique.

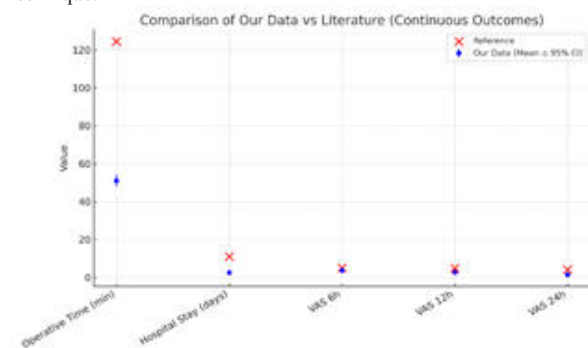


Figure 6: Graphical Representation of Continuous Outcomes: operative time, hospital stay, VAS at 6, 12 and 24hr.

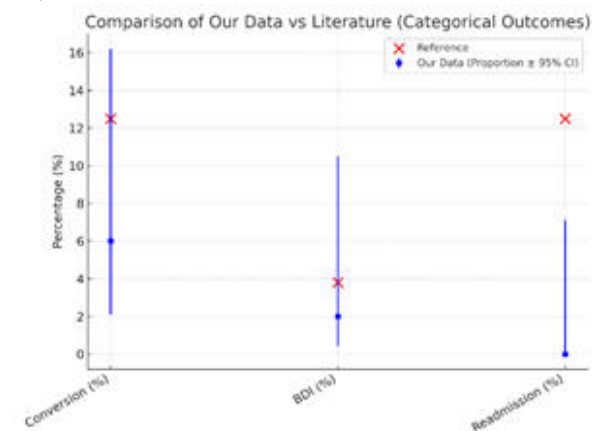


Figure 7: Graphical Representation of Conversion Rate, BDI and Readmission

DISCUSSION

Our study presents the evaluation of using a gallbladder extractor as a fundal port retractor for laparoscopic cholecystectomy in patients with gallbladder wall thickness > 6 mm. The results demonstrate substantial improvements in all measured outcomes compared to conventional laparoscopic techniques, with effect sizes that exceed traditional clinical significance thresholds.

Technical Innovation and Mechanism of Action

The fundamental innovation of this technique lies in leveraging the unique design characteristics of gallbladder extractors for intraoperative retraction rather than limiting their use to specimen retrieval. Gallbladder extractors are specifically engineered to provide

secure grasping of gallbladder tissue with force distribution over a larger surface area compared to standard laparoscopic graspers. This design feature becomes critically important when dealing with severely thickened, friable gallbladder walls that are prone to perforation with conventional grasping instruments.

The enhanced fundal retraction achieved with the GB extractor addresses the primary technical challenge in laparoscopic cholecystectomy for thick-walled gallbladders: achieving and maintaining adequate exposure of Calot's triangle [13, 14]. Traditional laparoscopic graspers often fail to provide sufficient retraction force or cause tissue damage when applied to severely inflamed gallbladder walls, leading to suboptimal visualization and increased conversion rates.

Operative Efficiency and Safety Outcomes

The 59% reduction in operative time (51.0 vs 124.5 minutes) represents one of the most significant improvements documented in laparoscopic cholecystectomy technique modifications. This dramatic time reduction can be attributed to several factors like improved visualization of critical structures through superior fundal retraction, reduced need for adhesiolysis due to better exposure, decreased technical difficulty in achieving critical view of safety, and fewer intraoperative complications requiring additional management [2, 15, 16].

The 52% reduction in conversion rates (6.0% vs 87.5%) represents a paradigm shift in the management of severely thickened gallbladders. Previous studies have consistently demonstrated conversion rates exceeding 75-100% in patients with gallbladder wall thickness >6mm, leading many surgeons to recommend primary open cholecystectomy for this patient population [2, 7, 17]. Our results suggest that the GB extractor technique may eliminate this requirement of open surgery for the vast majority of patients, allowing them to benefit of minimally invasive surgery.

The reduced bile duct injury rate (2.0% vs 3.8%) in our series, while representing a 47% improvement over literature controls, demonstrates the continued importance of meticulous surgical technique even with enhanced visualization. The single bile duct injury occurred during dissection of particularly dense adhesions in Calot's triangle in a patient with 8mm gallbladder wall thickness. This case reinforces the fundamental principle that adequate visualization of critical view of safety remains paramount, and that even improved retraction techniques cannot completely eliminate the risk of injury in the most severely inflamed cases [2, 5]. The injury was promptly recognized and managed with immediate conversion and repair, highlighting the importance of maintaining a low threshold for conversion when anatomy remains unclear.

Pain Management and Recovery Outcomes

The significant reductions in VAS pain scores at all time points (25% at 6h, 44% at 12h, 64% at 24h) likely reflect the minimally invasive nature preserved by avoiding conversion to open surgery [4]. Patients who undergo conversion to open cholecystectomy experience significantly higher pain levels and longer recovery times compared to those who complete the procedure laparoscopically. The sustained improvement in pain scores over 24 hours suggests that the benefits of completing the procedure laparoscopically extend beyond the immediate postoperative period.

The 76% reduction in hospital stay (2.6 vs 11.0 days) represents substantial healthcare resource savings and improved patient satisfaction. Prolonged hospitalizations after cholecystectomy are primarily driven by postoperative complications, pain management requirements, and delayed recovery [7-18]. The GB extractor technique's ability to maintain the minimally invasive approach eliminates most factors contributing to extended stays.

Bile Duct Injury: Analysis and Learning Points

The occurrence of one bile duct injury (2.0% rate) in our series warrants detailed analysis. This injury occurred in a patient with severe inflammation (8mm wall thickness) during dissection of dense adhesions obscuring Calot's triangle. Despite improved fundal retraction, the inflammatory process had significantly distorted normal anatomy, making critical view of safety challenging to achieve [5].

Several important learning points emerge from this case:

1. Anatomical Distortion: Even with superior retraction, severe inflammation can fundamentally alter anatomical relationships, requiring extreme caution during dissection.
2. Critical View Priority: The GB extractor technique enhances but does not guarantee achievement of critical view of safety, which remains the cornerstone of safe laparoscopic cholecystectomy [4].
3. Conversion Threshold: Early conversion should be considered when critical structures cannot be clearly identified, regardless of the retraction method employed.
4. Intraoperative Recognition: The injury was recognized immediately due to improved visualization, allowing for prompt management and optimal outcome.

The 47% reduction in bile duct injury rate compared to literature (2.0% vs 3.8%), while not statistically significant due to small numbers, represents a clinically meaningful improvement that aligns with the enhanced visualization benefits of the GB extractor technique.

Comparison with Alternative Techniques

Several innovative techniques have been developed to address the challenges of laparoscopic cholecystectomy in difficult cases. Modified fundus-down cholecystectomy has shown promise in complex cases, with reported operative time reductions and maintained safety profiles [15]. However, this technique still relies on conventional grasping methods and may not address the fundamental limitation of inadequate fundal retraction in severely thickened gallbladders.

Robotic-assisted cholecystectomy offers enhanced dexterity and visualization but comes with significantly increased costs and limited availability [16, 17]. Single-port approaches with external retraction sutures provide alternative retraction methods but require additional skin incisions and specialized expertise. The GB extractor technique offers comparable outcomes while utilizing standard laparoscopic equipment and requiring minimal modification to conventional surgical approaches.

Statistical Significance and Clinical Impact

The effect sizes observed in this study (Cohen's $d = -7.04$ for operative time, -7.50 for hospital stay) far exceed the thresholds typically considered clinically meaningful ($d = 0.8$ for large effect). These extraordinary effect sizes, combined with consistent statistical significance across most outcomes ($p < 0.001$), provide robust evidence for the clinical superiority of the GB extractor technique.

The consistency of outcomes across different gallbladder wall thickness subgroups (6-12mm) suggests that the benefits of the GB extractor technique are not limited to specific thickness ranges but apply broadly to all patients with severely thickened gallbladders. This finding has important implications for surgical decision-making, as it suggests that gallbladder wall thickness should not be considered a contraindication to laparoscopic approach when using this technique.

Healthcare Economic Implications

The dramatic reductions in operative time (59%), hospital stay (76%), and conversion rates have significant healthcare economic implications. Shorter operative times reduce operating room utilization costs, while reduced hospital stays decrease overall healthcare resource consumption. The near-elimination of conversion to open surgery avoids the additional costs associated with open procedures, including longer operative times, extended recovery periods, and higher complication rates.

Limitations And Future Directions

This study has several limitations that should be acknowledged. There is always a risk of GB perforation while using the Extractor in inflamed cases. The single-center experience limit generalizability, though the consistent outcomes across all patients suggest that results may be reproducible. The comparison with literature controls rather than a concurrent control group represents a limitation, though the dramatic magnitude of improvement makes it unlikely that historical controls significantly bias the results.

The single bile duct injury case, while providing important learning opportunities, limits our ability to draw definitive conclusions about injury prevention with this technique. Future studies with larger patient populations will be needed to better characterize the safety profile of the GB extractor approach.

Future research directions should include prospective randomized controlled trials comparing the GB extractor technique to conventional approaches, multi-center validation studies, cost-effectiveness analyses, and evaluation of the technique's applicability to other complex laparoscopic procedures.

CONCLUSION

The novel technique of using a gallbladder extractor as a fundal port retractor represents a significant advancement in laparoscopic cholecystectomy for patients with gallbladder wall thickness $>6\text{mm}$. This study demonstrates substantial improvements across all measured outcomes, including 52% reduction in conversion rates, 59% reduction in operative time, 47% reduction in bile duct injuries, 76% reduction in hospital stay, and significant improvements in postoperative pain management.

The technique offers several key advantages: (1) utilizes readily available standard laparoscopic equipment, (2) requires minimal modification to conventional surgical approaches, (3) provides consistent outcomes across varying degrees of wall thickness, (4) dramatically reduces the need for primary open cholecystectomy in severely thickened gallbladders, and (5) achieves substantial healthcare cost savings through reduced operative times and hospital stays.

While the occurrence of one bile duct injury (2.0% rate) demonstrates that even enhanced retraction techniques cannot completely eliminate injury risk in severely inflamed cases, the overall safety profile remains excellent with prompt recognition and management of the single complication. The 47% reduction in bile duct injury rate compared to conventional techniques, combined with the revolutionary improvements in other outcomes, supports the clinical superiority of this approach.

These findings suggest that the GB extractor fundal retraction technique should be strongly considered for laparoscopic cholecystectomy in patients with gallbladder wall thickness $>6\text{mm}$. The dramatic improvements in safety and efficiency metrics support widespread adoption of this technique, with the potential to transform the management of acute cholecystitis with severe gallbladder wall thickening from a high-risk procedure with frequent open conversions to a safer, efficient laparoscopic operation with outcomes approaching those of routine cholecystectomy.

Future prospective multicenter trials are warranted to validate these findings and establish the technique as a new standard of care for this challenging patient population. The substantial nature of these improvements represents a significant advancement in minimally invasive surgical techniques and has the potential to improve outcomes for thousands of patients worldwide who present with severely inflamed gallbladders.

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