

Research Article

Diagnostic Laparoscopy in Blunt Abdominal Trauma: A Descriptive Study

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ABSTRACT

Background: The role of laparoscopy in blunt abdominal trauma remains controversial, particularly in resource limited settings where diagnostic challenges are magnified. While laparoscopy is well established in penetrating trauma, its utility in hemodynamically stable patients with blunt abdominal trauma is not clearly defined. This study aimed to evaluate the role of diagnostic and therapeutic laparoscopy in the management of blunt abdominal trauma.

Methods: This descriptive study was conducted in the Department of Surgery at Nishtar Medical University and Hospital, Multan, Pakistan, over a six-month period. Hemodynamically stable patients with blunt abdominal trauma who underwent laparoscopic exploration were included. Data regarding demographics, cause of injury, computed tomography findings, intraoperative findings, surgical procedures, conversion rates, complications, and length of hospital stay were recorded. Organ injuries were graded according to the American Association for the Surgery of Trauma classification. Statistical analysis was performed using SPSS version 24.

Results: A total of 37 patients (28 laparoscopic, 9 converted) were included. Mean age was 34 years, with female predominance (89.2%). Assault was the predominant mechanism in the laparoscopic group (60.7%), while traffic accidents prevailed in the converted group (77.8%). Preoperative CT was negative in 35.7% of laparoscopically managed patients; notably, 30% of these required therapeutic intervention for grade 2 mesenteric injuries. The converted group had significantly higher Penetrating Abdominal Trauma Index scores ($p=0.008$). Conversion rate was 24.3%, with bleeding and complex injuries being common reasons. Complications occurred in 24.3% of patients, including five grade 3 and four grade 5 events. All four deaths occurred in severely injured polytrauma patients.

Conclusion: Diagnostic laparoscopy is a feasible and safe approach in hemodynamically stable patients with blunt abdominal trauma. It enables accurate diagnosis and therapeutic intervention, particularly when CT findings are negative but clinical suspicion persists. Larger multicenter studies are required to refine patient selection criteria.

Keywords: Blunt Abdominal Trauma, Laparoscopy, Diagnostic Laparoscopy, Therapeutic Laparoscopy, Conversion, Descriptive Study.

INTRODUCTION

Initially conceived as a diagnostic modality in the early 1900s, laparoscopy has, over subsequent decades, become an essential tool in both elective and emergency abdominal surgery [1,2]. Although early descriptions of "peritoneoscopy" for trauma date back to the 1970s, its widespread acceptance was hindered by technological limitations and the firmly established role of exploratory laparotomy as the reference standard [1]. The

principles guiding modern abdominal trauma management originated in 20th century military conflicts, where the high mortality associated with penetrating injuries prompted the routine adoption of mandatory laparotomy [2]. In parallel, the increasing frequency of blunt abdominal trauma (BAT) during the postwar period largely attributable to rising motor vehicle collisions necessitated the development of ancillary diagnostic techniques such as diagnostic peritoneal lavage (DPL) and,

subsequently, computed tomography (CT) to enhance diagnostic precision and curtail the rate of non-therapeutic operations [2,3]. The advent of minimally invasive surgery, propelled by innovations in video imaging and instrumentation, has rekindled interest in laparoscopy; it is now employed not only for diagnostic purposes but also for definitive therapeutic intervention in appropriately selected trauma patients [1,3].

Laparoscopy is increasingly utilized worldwide for managing penetrating abdominal trauma (PAT), with studies reporting sensitivity, specificity, and diagnostic accuracy approaching 100% [4,5]. Currently, the incidence of missed injuries is documented at less than 0.4%, while conversion rates vary between 7% and 47% [6,7,9].

In contrast, the utility of laparoscopy in blunt abdominal trauma (BAT) remains poorly established [10]. Compared to PAT patients, those sustaining BAT present with higher trauma severity scores and experience increased morbidity and mortality [11]. Blunt trauma frequently involves concomitant injuries, and physical assessment is often unreliable owing to distracting associated wounds [12]. Although computed tomography (CT) remains the diagnostic gold standard, its sensitivity for detecting hollow viscus injuries is limited. When diagnostic uncertainty persists, many clinicians regard exploratory laparotomy as a benign intervention [8]. While laparoscopy has been extensively adopted in PAT—demonstrating high accuracy, reduced morbidity, accelerated recovery, and shorter hospital stays [7]—its application in BAT is associated with substantial difficulties and remains infrequently documented in the literature.

This study aimed to assess the utility of diagnostic and therapeutic laparoscopy in the treatment of hemodynamically stable patients with blunt abdominal trauma treated at a tertiary academic center. Despite significant progress in imaging technology, the accurate detection of hollow viscus and mesenteric injuries continues to present a clinical challenge, and unnecessary non-therapeutic laparotomies contribute substantially to avoidable patient morbidity. A six months descriptive study was undertaken to characterize patient demographics, delineate the indications for operative intervention, record intraoperative findings and therapeutic procedures, and establish conversion rates to open laparotomy. An additional goal was to

identify the specific challenges associated with laparoscopic exploration in the context of blunt trauma and to assess postoperative outcomes, including complication rates and length of hospital stay. By reporting our institutional experience, we seek to contribute to the expanding body of literature supporting the selective use of laparoscopy in appropriately selected patients with blunt abdominal trauma.

METHODS

A descriptive study design was employed in the Department of Surgery at Nishtar Medical University/Hospital, Multan, over a six months period. Following ethical clearance from the institutional review committee, the study enrolled hemodynamically stable patients with blunt abdominal trauma who underwent laparoscopic management. During the study period, a total of 330 trauma patients underwent laparoscopic intervention, of whom 293 (88.8%) presented with penetrating abdominal trauma and 37 (11.2%) with blunt abdominal trauma (BAT). All 37 patients with BAT were included in the final analysis. Written informed consent was secured from each participant prior to inclusion. Baseline demographic information, clinical presentation, and pertinent medical history were documented using a standardized proforma. Exclusion criteria comprised patients managed with initial laparotomy or successful non-operative treatment, those with penetrating abdominal injuries, cases with incomplete medical records, and individuals below 12 years of age. Patients with penetrating abdominal trauma were specifically excluded as the study aimed to evaluate the role of laparoscopy exclusively in the blunt trauma population, where diagnostic challenges and clinical controversy regarding laparoscopic utility remain most pronounced. Additionally, patients undergoing immediate laparotomy without attempted laparoscopy were not included, as the study focused specifically on those deemed suitable for initial laparoscopic exploration.

All enrolled patients underwent diagnostic laparoscopy under general anesthesia. A standardized surgical approach was followed, beginning with pneumoperitoneum creation via either Veress needle insertion or the open Hasson technique at the umbilical site, with intra-abdominal pressure maintained between 12 and 15 mmHg. A 30degree laparoscope was inserted through a 10-mm umbilical port, and two additional 5-mm working ports were

placed in the right and left lower quadrants as required. Comprehensive four quadrant abdominal exploration was performed systematically in every case, encompassing inspection of the diaphragm, liver, spleen, stomach, entire small bowel from the ligament of Treitz to the ileocecal junction, colon, mesentery, and pelvic viscera. Retroperitoneal structures were examined when clinically indicated. Intraoperative findings, including the presence and nature of organ injuries, diaphragmatic involvement, hemoperitoneum grading (mild, moderate, or severe), and evidence of active hemorrhage, were meticulously recorded. Organ injury severity was classified according to the American Association for the Surgery of Trauma (AAST) grading system. To ensure procedural consistency and minimize interoperator variability, all laparoscopic interventions were performed by a single consultant surgeon with advanced expertise in minimally invasive surgery.

Comprehensive data collection encompassed patient demographics (age and sex), cause of injury and anatomical regions affected, Injury Severity Score (ISS), Penetrating Abdominal Trauma Index (PATI), computed tomography images (acquired using a 64-multislice scanner with intravenous and oral contrast as indicated), time interval from admission to surgery, indications for operative intervention, operative findings, surgical interventions undertaken, operative duration, reasons for conversion to open laparotomy, duration of hospitalization, and postoperative complications. Clinically significant complications were defined as those corresponding to Clavien–Dindo (CD) grades 3 through 5 and were included in the final analysis. Conversion to laparotomy was defined as the necessity to abandon the laparoscopic approach and perform an open incision to complete definitive surgical management. Patients undergoing conversion were designated as a distinct comparison group, based on the rationale that at the time of laparoscopy initiation, every patient was hemodynamically stable and the procedure was intended to be completed using minimally invasive techniques. Patients exhibiting hemodynamic instability defined as sustained systolic blood pressure below 90 mmHg despite adequate resuscitation or mean inspiratory pressure exceeding 30 mmHg were

deemed unsuitable for laparoscopic exploration and proceeded directly to laparotomy.

Statistical analysis was performed using SPSS version 24. Descriptive statistics summarized patient characteristics: continuous variables including age, ISS, PATI, operative time, and length of hospital stay were expressed as mean, median, minimum, and maximum values to accommodate non-normal distribution, whereas categorical variables such as gender, mechanism of injury, injury type, CT findings, and complication rates were presented as frequencies and percentages. The ShapiroWilk test was utilized to assess normality of data distribution. For comparative analysis between the laparoscopy and converted groups, Fisher's exact test was employed for categorical variables, while the Wilcoxon ranksum test (Mann Whitney U test) was applied to compare median values of continuous variables given the non-parametric nature of the data. Stratification was conducted for potential confounding variables including age and gender, with subsequent post stratification comparisons analyzed using appropriate statistical tests. A p-value of less than 0.05 was established as the threshold for statistical significance throughout all analyses.

RESULTS

Table 1: Patient Attributes

Among the 37 patients with blunt abdominal trauma (BAT) who underwent laparoscopic exploration, 28 (75.7%) were successfully managed laparoscopically 16 (57.2%) therapeutically and 12 (42.8%) diagnostically while 9 (24.3%) required conversion to open laparotomy. Assault was the predominant cause of injury in the laparoscopic group (60.7%), whereas traffic accidents prevailed in the converted group (77.8%). Preoperative computed tomography (CT) was negative in 10 patients (35.7%) within the laparoscopy group, with three (30%) of these individuals subsequently requiring therapeutic intervention for grade 2 mesenteric injuries. The converted group demonstrated significantly higher Penetrating Abdominal Trauma Index (PATI) scores ($p=0.008$). No significant intergroup differences were observed in Injury Severity Score (ISS), length of hospital stay (LOS), or complication rates.

Table 2: Intraoperative Observations and Therapeutic Measures

	Laparoscopic	Converted	Total	P-Value
Total	28(75.7%)	9 (24.3%)	37	
Age (Years)	31/25 (16–57)	48/44 (26–65)	34/29.6 (16–65)	<0.001
Sex				
Male	3	1	4	0.56
Female	25	8	33	
Cause Of Injury				
Assault	17 (60.7%)	1 (12.5%)	18 (48.6%)	0.13
Traffic Accident	11 (39.2%)	7 (77.8%)	18 (48.6%)	
Fall	0	1 (11.1%)	1 (2.7%)	
Anatomical Regions Affected				
Isolated Abdominal Injury	16(57.1%)	5 (55.6%)	21 (56.8%)	0.56
Two Or More	12 (42.9%)	4(44.4%)	16(43.2%)	
Concomitant Injuries				
Head Injury	4	1	5	0.67
Thoracic Injury	1	1	2	0.73
Long Bone Fractures	3	1	4	0.56
Abdominal Computed Tomography				
Positive	18 (64.2%)	7 (77.8%)	25(67.6%)	0.04
Negative	10 (35.7%)	1 (11.11%)	11 (29.7%)	
Not Performed	0	1 (11.11%)	1 (2.7%)	
Trauma Severity Indices				
ISS	10.5/9 (5–39)	11/13 (5–19)	11/9 (5–39)	0.77
PATI	5/5 (0–13)	11/8 (3–27)	7/5 (0–27)	0.008
Type Of Laparoscopy				
Diagnostic	12 (42.8%)	0		
Therapeutic	16 (57.2%)	9 (100%)		
LOS	10/7 (1–48)	10/11 (6–19)	11/9 (4–37)	0.98
Outcomes:				
CD 3	3 (10.7%)	2 (22.2%)	5 (13.51%)	0.38
CD 5	1 (3.6%)	3(33.3%)	4 (11%)	
No Complications	24 (85.7%)	4 (44.4%)	28 (75.7%)	

Small bowel injuries (grades 1–3) constituted the most common finding, identified in 11 patients; of these, seven were successfully managed laparoscopically, while four required conversion to open surgery. Colonic injuries necessitated repair in ten instances and stoma creation in four. Mesenteric injuries were observed in 12 patients, making them the most frequent injury type, with surgical repair performed in seven cases. Regarding solid organ injuries, seven liver injuries were

managed entirely within the laparoscopic group, whereas all three splenic injuries required conversion. Two renal injuries were successfully managed laparoscopically. Additionally, four urinary bladder injuries were treated laparoscopically, with bladder repair undertaken in two patients. Of note, all duodenal injuries (three patients) and all splenic injuries necessitated conversion to an open approach.

Table 3: Patients with Significant Complications

Intra-Abdominal Injuries And Surgical Interventions	Laparoscopic Group	Converted Group	Total
Small Intestine (Grades 1–3)	7	4	11
Duodenal Injury (Grades 1 And 3)	0	3	3
Colonic Injury (Grades 1–2)	1	2	3
Bowel Resection With Anastomosis	–	1	1
Primary Repair	6	4	10
Enterostomy Creation	3	1	4
Mesentery (Grades 1, 2, 3)	8	4	12

Repair	2	5	7
Hepatic Injury (Grades 1–3)	7	0	7
Spleen (Grades 3, 4)	0	3	3
Splenorrhaphy	–	1	1
Splenic Excision	–	1	1
Renal Injury (Grade 2)	2	–	2
Bladder Injury (Grades 2–3)	4	–	4
Cystorrhaphy	2	–	2

A total of 9 patients (24.3%) developed clinically significant complications, including 5 (13.5%) with Clavien-Dindo grade 3 and 4 (10.8%) with grade 5 complications. Among patients' with grade 3 complications, a patient from the laparoscopic cohort required imageguided drainage of an intraperitoneal collection after small bowel and mesentery repair. Another laparoscopic patient developed portsite wound infection following diagnostic laparoscopy with no abdominal injury. Within the converted group, a patient developed postoperative pneumonia after small bowel and mesentery repair, and another had a conservatively managed surgical site infection following

mesentery repair. One additional patient in the laparoscopic group who underwent therapeutic laparoscopy required relook laparotomy for an intra-abdominal abscess after colon and mesentery repair. All four deaths occurred in severely injured patients (ISS range 8-30). In the laparoscopic group, one death followed relook laparotomy for bleeding and subsequent multiorgan failure after liver repair. In the converted group, one patient died from pulmonary embolism after splenorrhaphy. The remaining two deaths were in laparoscopic patients with no abdominal injuries: one from severe head trauma, and one from severe head trauma with intracranial hemorrhage leading to brain death.

Cdgrade, Age	Injury Mechanism And Concomitant Injuries	Type Of Laparoscopy	ISS/PAT	LOS, Days	Abdominal Injury Grade And Surgical Intervention	Complications
CD 3,50	Road Traffic Crash, Severe Head Trauma, Craniotomy	Therapeutic	17/14	32	Small Bowel Grade 2, Repair; Mesenteric Grade 2, Repair	Percutaneous Drainage Of Intra-Abdominal Abscess
CD 3,36	Assault	Diagnostic	9/4	8	No Injuries	Portsite Wound Infection
CD 3,40	Road Traffic Crash, Severe Head Trauma, Pneumothorax, Intercostal Drain	Converted	14/10	15	Small Bowel Gr 2, Repair; Mesentery Gr 2, Repair	Postoperative Pneumonia
CD 3,40	Road Traffic Crash, Long Bone Fractures	Converted	12/8	14	Mesenteric Grade 2 Repair	Surgical Site Infection
CD 3,26	Road Traffic Crash, Long Bone Fractures	Therapeutic	13/9	16	Colon Gr 2, Repair; Mesentery Gr 2, Repair	Relook Laparotomy For Intra-Abdominal Abscess
CD 5,37	Assault	Therapeutic	10/6	12	Liver Grade 2	Relook For Bleeding, Multi-Organ Failure
CD 5,64	Assault	Converted	9/5	11	Spleen Gr 3, Splenorrhaphy	Pulmonary Embolism

CD 5,51	Assault	Diagnostic	8/2	5	No Injuries	"Severe Head Trauma"
CD 5,52	Assault, Severe Head Trauma, Intracranial Hemorrhage	Diagnostic	30/4	2	No Injuries	Severe Head Injury, Brain Death

DISCUSSION

In the present study, preoperative abdominal CT was obtained in 36 of 37 patients (97.3%). CT findings were positive in 25 patients (67.6%), negative in 11 (29.7%), and not performed in one (2.7%). Within the laparoscopically managed group, 10 patients (35.7%) had negative CT scans; notably, three of these individuals (30%) underwent laparoscopic intervention for grade 2 mesenteric injuries. These findings underscore this reality that a substantial proportion of patients may exhibit falsenegative CT results, and that definitive management may be postponed if clinical suspicion is not maintained. Laparoscopy in such cases provides both accurate diagnosis and the opportunity for therapeutic intervention.

The challenge of diagnosing intra-abdominal injuries in BAT is well recognized. Only 5% to 10% of individuals with BAT sustain injuries requiring surgical intervention, and up to 10% of these patients may present with an unremarkable physical assessment [14]. Occult lesions necessitating targeted therapy have been documented even in the absence of concomitant wounds or abdominal discomfort [15]. Although radiologic evaluation enhances overall accuracy, it remains an imperfect tool. Computed tomography remains the standard imaging modality for hemodynamically stable individuals with BAT, despite its inherent limitations [9,20,21]. Hollow viscus injuries are particularly difficult to identify on CT, and in many cases only indirect signs of injury are present, which may result in undetected injuries and postponed operative intervention [18]. A delay of as little as five hours in the operative management of hollow visceral injuries has been shown to increase both morbidity and mortality [19].

Focused Assessment with Sonography in Trauma (FAST) is a bedside, non-invasive technique for detecting intraperitoneal fluid collections; however, its accuracy depends greatly on operator experience. It is frequently used as a complementary tool during the initial assessment in accordance with Advanced Trauma Life Support (ATLS)

protocols. Nevertheless, Avila J [16] documented that 1.7% of individuals with a negative FAST examination had visceral injuries, and 23% of these individuals ultimately underwent therapeutic laparotomy. Moreover, an investigation from the United States demonstrated that the diagnostic sensitivity of FAST in hemodynamically stable BAT cohorts was only 22%, prompting the authors to recommend direct progression to computed tomography (CT) whenever feasible [17]. Laparoscopy in such cases enables both accurate identification and therapeutic management of occult intra-abdominal injuries. Nevertheless, the optimal timing for laparoscopic intervention and the criteria for selecting patients who may safely undergo non-surgical observation remain subjects of ongoing debate [19].

Several tools have been developed to aid in early decision-making. The Bowel Injury Prediction Score (BIPS), which integrates radiographic, laboratory, and physical examination findings, has been proposed to identify patients at high risk for bowel injury who may benefit from early diagnostic laparoscopy [19]. A score of 2 or greater is considered highly suggestive of such injuries; however, this scoring system has not yet undergone prospective validation and was not employed in the present study [19].

Diagnostic peritoneal lavage (DPL), once a mainstay in the evaluation of blunt abdominal trauma, has fallen out of favor due to its high sensitivity and low specificity, which may contribute to unnecessary laparotomies [22]. A more recent adaptation, laparoscopic assessment in surgical trauma (LAST), has been proposed as a potential screening tool performed under local anesthesia in the trauma resuscitation area [13]. While LAST appears to be a promising rapid assessment modality, further research is required to establish its clinical utility and reliability [13].

At the study institution, all hemodynamically stable patients with suspected intra-abdominal injury following blunt trauma undergo diagnostic laparoscopy as the initial surgical intervention, with conversion to laparotomy

reserved for cases meeting predefined criteria. Indications for surgical exploration include signs of peritonitis, positive imaging findings, highrisk mechanisms such as the presence of a seatbelt sign, and equivocal or worsening abdominal examination. These indications are consistent with those reported in the literature [20,22-24]. In the present series, small bowel and mesenteric injuries were the most frequently encountered, aligning with previously published data [25]. Further studies are needed to more clearly define the indications for diagnostic laparoscopy and to determine which patients may be safely managed without surgical intervention.

Most patients with blunt abdominal trauma sustain injuries in road traffic collisions and frequently present with concomitant injuries. In this present series, concomitant injuries were observed in 43% of the cohort, though injury mechanism did not affect the probability of successful laparoscopic intervention. Delayed recognition of intra-abdominal injuries in these individuals has been linked to complication rates ranging from 25% to 65% [5].

Although the (ISS) was higher in the converted group, this difference did not reach statistical significance. In contrast, the (PATI) was significantly higher in patients requiring conversion ($p=0.008$), suggesting that injuries of greater intra-abdominal complexity ultimately necessitated an open procedure.

Individuals with major physiological disturbances and severe concomitant injuries are frequently unsuitable for laparoscopic intervention, and their recovery is largely determined by the convalescence of these extraperitoneal injuries, which may offset the potential benefits of laparoscopy, including reduced hospital stay and duration of ventilatory support [26]. In the current series, length of hospitalization (LOS) did not differ significantly between groups, a finding attributed to the presence of associated injuries and consistent with the report by Pau L. [10]. Although adverse events were more frequent among converted patients, this was likely related to the greater complexity of intra-abdominal injuries. All four deaths in this series occurred in severely injured multiple trauma patients. In this present series, two fatalities within the laparoscopy cohort resulted from severe head trauma and were not attributable to the laparoscopic procedure itself. Although the application of laparoscopy in individuals with head injury remains

controversial, its potential benefits, including reduced surgical trauma and accelerated convalescence, might outweigh the theoretical risk of increased intracranial pressure during pneumoperitoneum. Nonetheless, head injury has been cited by some authors as a relative contraindication to laparoscopic intervention, and further research is warranted to clarify this issue [20].

At this institution, diagnostic laparoscopy is routinely performed in every hemodynamically stable patient requiring surgical exploration following blunt abdominal trauma. A systematic abdominal exploration is essential to avoid missed injuries, and proficiency in advanced laparoscopic skills, including optical scope guidance, visceral mobilization, complete enteric examination, and intracorporeal suturing techniques, has been emphasized as critical for successful trauma laparoscopy [13].

The conversion rate in the current series was 24.3%, comparable to the 23% reported in other series and higher than the 11.7% rate typically observed in penetrating trauma [13]. This difference likely underscores the increased complexity and higher number of intra-abdominal injuries associated with blunt mechanisms. Reported conversion rates in the literature span 8.5% to 37%, based on patient cohort characteristics [22,25,27,28]. In this present study, conversions were necessitated by uncontrollable bleeding, multiorgan injury, suboptimal visualization, and device malfunction. Although such events were not seen in this cohort, cardiopulmonary instability during laparoscopy must also prompt immediate conversion to laparotomy [13].

The advantages of laparoscopic over open approaches in the setting of abdominal trauma are thoroughly established. Previous studies have reported that laparoscopic management reduces or eliminates unnecessary non-therapeutic laparotomies, lowers rates of postoperative complications and death, decreases postoperative discomfort, accelerates convalescence, and shortens hospital stay [5,10,29,30].

Several limitations of this study should be acknowledged. First, the retrospective nature and limited cohort size restrict the applicability of these results to broader populations. Additionally, followup data were not systematically collected. The findings of this investigation are highly contingent upon the laparoscopic proficiency of the attending surgeon and may therefore only be

reproducible in centers with comparable skill levels. Comparisons between the laparoscopic and converted groups should be interpreted with caution due to group heterogeneity and small numbers. Furthermore, length of hospital stay (LOS) was calculated as total admission duration and does not necessarily reflect the postoperative recovery period specific to laparoscopy. Notwithstanding these constraints, this current investigation contributes meaningful perspectives on the utility of laparoscopy in blunt abdominal trauma and underscores the difficulties associated with its use in this patient population.

CONCLUSION

Diagnostic laparoscopy appears to be a feasible and safe approach for hemodynamically stable patients with blunt abdominal trauma. In selected patients, it allows accurate diagnosis and therapeutic intervention while potentially avoiding unnecessary non-therapeutic laparotomies. The procedure may be particularly useful in patients with negative computed tomography findings but persistent clinical suspicion. In such cases, hollow viscus or mesenteric injuries may still be identified and managed. The complexity of more severe intra-abdominal injuries, reflected by higher PATI scores in patients requiring conversion, may increase the difficulty of laparoscopic exploration. Although associated extra-abdominal injuries can prolong recovery and obscure the benefits of minimally invasive surgery, the selective use of laparoscopy remains a valuable adjunct in equivocal cases. Larger multicenter studies are required to refine patient selection criteria and validate these findings.

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