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Abdominal Drainage in Peacetime and Wartime: An Expert Consensus

Tian Zhou[1], Chenglong Zhu[1], Feixiang Wu[2], Xingzhi Liao[3], Wenyun Xu[4], Hui Chen[5], Jinlong Qu[6], Jinfei Shi[7], Yaohua Yu[8], Ying Huang[9], Miao Zhou[10], Hua Tang[11], Shengyun Cai[12], Wenchao Gao[13], Zui Zou[1]

[1]School of Anesthesiology, Naval Medical University, Shanghai, 200433, China. [2]Department of Anesthesiology, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, Zhejiang Province, China. [3]Department of Anesthesiology, The 904th Hospital of the Logistics Support Force of the Chinese People's Liberation Army, Wuxi 214044, Jiangsu Province, China. [4]Department of Anesthesiology, Shanghai Changzheng Hospital, Naval Medical University, Shanghai, 200003, China. [5]Department of Anesthesiology and Perioperative medicine, Shanghai Fourth People's Hospital, School of Medicine, Tongji University, Shanghai 200434, China. [6]Department of Emergency and Critical Care Medicine, Shanghai Changzheng Hospital, Naval Medical University, Shanghai 200003, China. [7]Department of Anesthesiology, Anhui Provincial Hospital of the Armed Police, Hefei 230001, Anhui Province, China. [8]Department of Anesthesiology, The First Hospital of Putian City, Putian 351100, Fujian Province, China. [9]Department of Intensive Care Unit, the Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University, Huai'an 223300, Jiangsu Province, China. [10]Department of Anesthesiology, the Affiliated Cancer Hospital of Nanjing Medical University, Jiangsu Cancer Hospital, Jiangsu Institute of Cancer Research, Nanjing Medical University, Nanjing 210009, Jiangsu Province, China. [11]Department of Thoracic Surgery, Shanghai Changzheng Hospital, Naval Medical University, Shanghai 200003, China. [12]Department of Obstetrics and Gynecology, The First Affiliated Hospital of Naval Medical University, Shanghai 200433, China. [13]Department of Colorectal Surgery, Shanghai Changzheng Hospital, Naval Medical University, Shanghai 200003, China.

Corresponding authors: Shengyun Cai, Wenchao Gao and Zui Zou.

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Abstract

Abdominal drainage is a key technique in abdominal surgery, primarily aimed at removing fluid, gas, foreign bodies, and necrotic tissue from the peritoneal cavity, reducing the risk of infection, and promoting recovery. The placement and strategy of abdominal drainage should be decided based on individual circumstances to minimize the risk of complications and accelerate the patient's recovery. In wartime, abdominal drainage is mainly used to control intraperitoneal hemorrhage and intraperitoneal infection. This consensus aims to enhance understanding of the application and management of abdominal drainage during both peacetime and wartime, with the goal of improving drainage therapy outcomes and patient safety.

Keywords: Abdominal drainage, drainage tubes, clinical application, wartime medicine, procedural standards

Introduction

Drainage is a fundamental surgical procedure with a long history. The controversy over whether to perform an abdominal drainage persists [1]. Drainage for therapeutic purposes is undoubtedly beneficial, but the placement of prophylactic drainage is fraught with controversy [2-4]. However, peritoneal drainage is of vital importance in both wartime and peacetime, especially for patients with intra-abdominal infections [5]. Additionally, the

Address correspondence to: Shengyun Cai, Department of Obstetrics and Gynecology, First Affiliated Hospital of Naval Medical University, 168 Changhai Road, Shanghai 200433, China. Email: caicai24@126.com. **Wenchao Gao,** Department of Colorectal Surgery, Second Affiliated Hospital of Naval Medical University, 415 Fengyang Road, Shanghai 200003, China. Email: gaowenchao2007@163.com. **Zui Zou,** School of Anesthesiology, Naval Medical University, 168 Changhai Road, Shanghai 200433, China. Email: zouzui@smmu.edu.cn.

invention of new technologies and materials has facilitated the continuous development of drainage tubes to meet the needs of modern medicine [6]. In peacetime, when healthcare resources are abundant, accelerating recovery is a priority [7]. During wartime, medical resources are extremely limited, and it is crucial to efficiently and safely manage drainage of liver, duodenum, and pancreas injuries. Therefore, there is a need for new types of drainage tubes that are suitable for the wartime medical environment [8]. We analyzed the purpose of abdominal drainage, the different types of drainage tubes, indications for peritoneal drainage, and the use of drainage tubes in the battlefield environment. The purpose of this consensus is to clarify the main uses of peritoneal drainage and provide systematic guidance for healthcare providers to help medical workers implement abdominal drainage properly in different clinical conditions and with limited resources, and to correctly choose and apply drainage tubes to achieve better treatment outcomes.

The objective of abdominal drainage

Abdominal drainage has the basic function of clearing fluid from the abdominal cavity, such as pus, blood, bile, pancreatic juice, and gastrointestinal contents, and preventing them from accumulating again. This helps to reduce the occurrence of infections and damage to organs, promote the resolution of inflammation, and facilitate wound healing [2, 9-13]. In acute pancreatitis, necrotizing pancreatitis, and acute appendicitis with periappendiceal abscess, abdominal drainage can effectively remove necrotic tissue and control infection; alleviate abdominal pain, nausea, and vomiting; reduce the incidence of gastrointestinal obstruction, systemic inflammatory response syndrome, and other complications [14-16]. A abdominal drainage tube can also be used for flushing and, in some cases, used as a delivery channel to administer medication to the patient for treatment [11, 17]. Monitoring and analyzing the drainage also play an important role in preventing postoperative complications such as hemorrhage, anastomotic fistula, biliary fistula, and pancreatic fistula.

Based on the purpose of drainage, peritoneal drainage is divided into prophylactic drainage and therapeutic drainage [18]. These two types of drainage can sometimes be difficult to distinguish in clinical practice. Therapeutic drainage is used for clear intra-abdominal infections or injuries, such as intra-abdominal abscesses, intra-abdominal hematomas and pancreatic necrosis. [11, 15, 19]. Peritoneal drainage allows patients' conditions to improve effectively, therefore therapeutic drainage is necessary and beyond doubt. Prophylactic drainage is mainly used to monitor the presence of postoperative complications such as active bleeding or anastomotic leak. After abdominal surgeries such as pancreaticoduodenectomy, liver resection, splenectomy, and colorectal surgery, placing a peritoneal drainage tube prophylactically enables continuous monitoring and timely evacuation of blood and gastrointestinal contents, and effectively preventing the occurrence of severe complications such as peritonitis [18, 20-22].

Types of abdominal drainage

Passive drainage: Passive drainage does not rely on external power, but relies on gravity, pressure difference or capillary action, such as drainage by a tube or cigarette drains [1]. The Penrose drain is a famous invention of cigarette drainage in history. Passive diversion has a low efficiency and is prone to blockage, increasing the risk of retrograde infection, and it is now used less frequently. Nevertheless, passive drainage tube is facile to manufacture and can be utilized for draining in times of war if necessary.

Active drainage: Active drainage requires an external device to provide negative pressure suction, thereby increasing the suction effect and more effectively removing the suction material. Active drainage devices are typically composed of an outer sump tube and an inner suction tube [23]. Additionally, vacuum sealing drainage (VSD) combines the concepts of "negative pressure, closed, and drainage", using wrapping materials, sealing films, drainage tubes, and external negative pressure suction devices. It has been proven effective in treating severe abdominal infections, preventing wound infections, and promoting healing of burns [7, 24, 25].

Indications of abdominal drainage

Intraperitoneal abscess

An abdominal abscess is formed by a fibrin matrix containing pus. The efficacy of systemic antibiotic therapy diminishes once a peritoneal abscess becomes encapsulated by intraperitoneal tissue and forms cyctic structure. A CT scan is usually the best way to diagnose an abdominal abscess [2]. Appendicitis and diverticulitis are common

causes of intestinal perforation and the formation of abscesses in the abdominal cavity. Whether drainage is performed depends on the size of the abscess [26, 27]. For peritoneal abscesses less than 3cm in size, non-surgical management is effective and safe. Patients with larger peritoneal abscesses (greater than 3 cm) may benefit from percutaneous drainage, which provides a less invasive intervention to to prevent the occurrence of sepsis, stabilizes the patient's condition, reduces the recurrence of abscesses, and provides time to find the cause [2, 27]. Goje et al. conducted a systematic review of the research on minimally invasive treatment of peritoneal abscesses and concluded that compared with conservative treatment with a single antibiotic, minimally invasive techniques (laparoscopic, ultrasound or CT-guided drainage) offer good therapeutic effects; compared with laparoscopy, image-guided puncture drainage has a higher success rate, fewer complications, and shorter hospital stay [28]. However, compared to simply using antibiotics, percutaneous drainage may result in more severe postoperative complications [29]. Therefore, considering the adverse events of peritoneal drainage, surgical treatment should be chosen for difficult percutaneous abdominal drainage insertion and antibiotic failure in patients with intra-abdominal abscesses [27].

Pancreas

For patients with infectious pancreatic necrosis, drainage is recommended [15, 30]. Percutaneous drainage and transwall endoscopic drainage are both treatment options for Walled-off pancreatic necrosis(WON). Percutaneous drainage may result in pancreatic fistulas, but it is a useful supplement to endoscopic drainage for WON patients with severe conditions that cannot be treated by endoscopy or those with deep extensions [15]. For patients diagnosed with necrotizing pancreatitis, no significant difference in complications was observed between early drainage within 24 hours and delayed drainage during the stage of localization formation, and patients assigned to the delayed drainage strategy received fewer invasive interventions [10]. The later drainage intervention for infective necrotizing pancreatitis also aligns with the previous studies' viewpoint [31].

In acute pancreatitis, abdominal drainage is used for the treatment of dysfunction of the gastric outlet resulting from persistent accumulation of pancreatic or peripancreatic fluid, pseudocyst formation, or progression to necrotizing pancreatitis [14]. In rats with acute severe pancreatitis, peritoneal drainage can reduce the severity of pancreatitis and intestinal inflammation [32, 33]. Interestingly, another study found that early peritoneal drainage can promote recovery in severe acute pancreatitis, with the authors explaining that drainage can block the harmful pathophysiological process of pancreatitis-related peritoneal effusion [34].

For pancreaticoduodenectomy, the benefits of postoperative routine drainage are not clear due to the lack of research evidence and the low persuasiveness of the research evidence [35]. Prophylactic peritoneal drainage after pancreaticoduodenectomy may be associated with a higher mortality rate, but has a lower incidence of complications [4]. Distal pancreatectomy with no routine post-operative abdominal drainage is associated with lower rates of major complications, pancreatic fistulas, and readmissions [36]. In general, there is no strong evidence to support the use of prophylactic drainage for pancreatic surgery [22].

Liver and gallbladder

Earlier studies indicated that there was no evidence to support the routine use of drainage tubes after non-complex liver resection [13]. However, a study indicates that peritoneal drainage is helpful in monitoring and treating postoperative complications for patients undergoing elective liver resection [37]. But recent studies have refuted the use of peritoneal drainage after non-complex liver resection, as it increases the risk of wound-related complications but does not reduce the risk of subsequent interventions [38]. Similarly, the use of prophylactic drainage in partial hepatectomy is also uncertain [21].

For patients with liver abscess, ultrasound or CT-guided needle puncture with aspirative drainage is the current standard of care, and bile drainage fluid is an important element in classifying liver abscesses [39].

Acute cholecystitis is not an absolute indication for peritoneal drainage. Placing an abdominal drain after laparoscopic cholecystectomy may not be beneficial for patients, instead, it prolongs the postoperative hospital stay of patients [40]. A randomized controlled study suggests that even with the risk of perforated gallbladder, elective day-case laparoscopic cholecystectomy without drain placement is safe and has fewer complications, such as

postoperative fever [41]. These views seem to be consistent with earlier research [42]. When acute calculous cholecystitis occurs, gallbladder drainage under laparoscopy can avoid open surgery [43]. Additionally, for a cholecystectomy with spilled gallstone, abdominal drainage is an optional treatment [44].

Appendix

For patients with complicated appendicitis, the necessity of performing abdominal drainage after appendectomy has been questioned, as it may increase the overall incidence of complications and hospital stay, thereby prolonging the recovery period [45, 46]. Some scholars even believe that abdominal drainage is a risk factor for postoperative infection in the operative area after appendectomy [47].

Colorectum

Many studies have indicated abdominal drainage after colorectal surgery dose not offer significant benefits compared to no drainage and routine drainage does not significantly affect the incidence of colorectal anastomotic leakage [48-50]. Meanwhile, The placement of a drainage tube in constructing lateral ostomy is often correlated to local necrosis [51]. Additionally, the placement of abdominal drains after elective colorectal surgery is associated with a non-clinically significant longer ostoperative duration of stay, negating the routine use of abdominal drainage in colorectal surgery [52].

Wartime abdominal drainage

Despite some doubts about its effectiveness in certain situations, peritoneal drainage remains an essential treatment in peacetime. Similarly, in wartime conditions, peritoneal drainage plays an important role in medical care.

For intra-abdominal infections such as cholecystitis, acute cholangitis, acute left hemicolon diverticulitis, and postoperative peritonitis, abdominal drainage can be considered as a treatment option [43]. The utilization of abdominal drainage can effectively control the source of infection, facilitating the management of abdominal abscesses or infected abdominal fluid [5, 43]. Percutaneous drainage is a safe and effective procedure in most cases, with an effectiveness rate of around 85% [5]. It allows for minimally invasive removal of abdominal and pelvic abscesses and fluid collections, with a lower rate of mortality and complications [5]. In blunt abdominal injuries, abdominal drainage can remove the collection of blood and fluid, reducing the risk of abdominal fluid accumulation [53]. If no drainage is performed, the accumulation of fluid in the abdominal cavity may lead to or confuse complications such as bleeding, peritonitis, abdominal compartment syndrome, systemic inflammatory response, and respiratory distress [53]. In the event of an open abdominal injury, the placement of a temporary abdominal closure device with a drainage tube as part of an damage control surgical technique facilitates early identification, drainage residual infection and removal of peritoneal fluid, thereby reducing the risk of abdominal compartment syndrome [5]. Surgical debridement should be considered when conservative management or percutaneous drainage fails [54]. Despite many low-quality studies claiming that abdominal drainage should be avoided, scholars generally agree that drainage should be placed in cases of severe peritoneal contamination, high risk of fluid collection, and peritonitis [55].

The liver is the largest solid organ in the abdominal cavity. When liver injury is accompanied by intrahepatic abscess and delayed post-traumatic biliary fistula, drainage of the peritoneal cavity should be performed [56]. The combination of percutaneous drainage and endoscopic techniques may be considered, rather than percutaneous treatment alone [56]. Percutaneous drainage can also serve as the primary treatment option for splenic abscess following non-surgical management of splenic injury [57].

In battlefield conditions, the abdominal drainage tube may face problems such as falling off, blockage, difficulty in automatic drainage, and decreased drainage quality. Consequently, the drainage tube must be designed with a robust fixation mechanism to avert unintended dislodgment during the rescue operation [58]. It should also have a convenient anti-blockage structure and an anti-backflow structure to quickly resolve any blockages in the tube and restore normal functioning of itself [6]. Furthermore, the placement of the peritoneal drainage tube has a negative impact on the patient's mobility and is not conducive to the patient's postoperative recovery. Therefore, the drainage tube should be designed to be lightweight and securely fixed [55]. Additionally, the medical resources and personnel on the battlefield are limited, and it is not possible to provide comprehensive monitoring for every injured person in real time. Therefore, the drainage tube can also be

integrated with alarm and monitoring functions to prevent the drainage tube from falling off or becoming blocked for too long without being treated [58].

Conclusion

In summary, the application of abdominal drainage technology has significant importance and necessity both in peacetime and wartime. In peacetime medical care, abdominal drainage plays an important role in preventing and dealing with postoperative complications in the abdomen, promoting wound healing, and reducing the risk of infection; in wartime situations, the importance of abdominal drainage in monitoring bleeding, removing contaminants, and preventing infection is even more prominent. The difficulties in transportation and the shortage of medical personnel during field rescue operations have prompted the development of more reliable and less prone to blockage drainage tubes, as well as real-time monitoring of drainage conditions, to enhance drainage effectiveness. In the future, abdominal drainage will move towards portability and intelligence to meet the needs of peacetime and wartime.

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