The uses and abuses of drains in abdominal surgery

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Controversy surrounds the indications for and effectiveness of the abdominal drain. There are a variety of factors which mitigate against formulating rigid guidelines for the indications of drains, but surgeons should understand the benefits and applications of drainage and the tissue responses to the constituent materials. Drains are not a substitute for meticulous surgical technique.

Throughout the history of surgery, drainage of the abdominal cavity has been a controversial subject. Yates (1905) claimed that 'drainage of the general peritoneal cavity is physically and physiologically impossible'. He also confirmed Gravitz's observation that the 'peritoneum is able to reabsorb secretions and combat bacteria'. Over 97 years later, confusion still reigns supreme in this critical area of abdominal surgery. This article is an attempt to document a logical approach to the drainage of the abdominal cavity based on a review of the literature and on current surgical practice.

TYPES OF DRAINS

There are two basic types of drains, passive and active (*Table 1*). The majority of active drains use a closed vacuum system. A sump drain, which is open to the atmosphere via a separate lumen, is an active form of drainage system used for evacuating large amounts of fluid. The efficiency of an active drain depends on:

1. The amount of negative pressure
2. The diameter and length of the drain tube
3. The viscosity and the consistency of the drainage fluid.

INDICATIONS AND CONTROVERSIES OF INTRA-ABDOMINAL DRAINS

Table 2 provides some important indications for abdominal drainage. The following discussion elaborates in a systemic manner the relevant controversies of surgical drains in both elective and emergency situations.

TABLE 1.
Comparison of active and passive drain

	Active drain	Passive drain
Function	Works by negative pressure created by compressible drums or mechanical evacuation system	Depends on pressure differentials and gravity
Pressure gradient	Low to moderate negative −100 to −150 mmHg High negative −300 to −500 mmHg (sump only)	Positive
Drain exit site	Dependent position not necessary	Dependent position for best function
Drain site dressing	Minimal or not required	Bulky to absorb fluid output
Measurement of effluent	Reliable and accurate	Difficult to quantify
Fluid collections	Decrease incidence because negative pressure improves tissue apposition and obliterates dead space	Increase incidence because of limited effect on the dead space
Retrograde infection	Lower incidence especially with closed suction system	Higher incidence with open system
Obstruction of drain	More common because of smaller calibre	Less common
Radiographic studies via drain	Easy to perform	Difficult except in special circumstances, e.g. T-tube and NGT
Pressure necrosis	Greater incidence	Less common

NGT = nasogastric tube

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HOLLOW ORGANS

Stomach and duodenum

Accumulation of a large amount of gastric secretions as a result of gastric stasis following abdominal surgery leads to gastric dilatation, nausea, vomiting and aspiration pneumonia. A nasogastric tube (NGT) is therefore routinely used to decompress the upper gastrointestinal tract and hasten the recovery of normal physiological functions. However, nine randomized trials (*Table 3*) have shown higher complication rates, especially pulmonary problems, related to the use of a NGT after elective abdominal surgery. Wolff et al (1989) revealed that although the omission of a NGT following elective colorectal procedures led to a significantly higher incidence of abdominal distension, nausea and vomiting, it was uncomfortable, expensive and did not benefit the majority of their patients. The authors therefore advised against its routine use in the postoperative period. In a meta-analysis of selective *vs* routine nasogastric decompression consisting of 26 clinical trials (3964 patients) (Cheatham et al, 1995), the number of complications, including wound infections, were significantly fewer and the number of days to first oral intake were significantly less in patients treated without NGTs. However, abdominal distension and vomiting were significantly more common in these patients, which led to NGT insertion in 5–7% of patients. Based on these findings, nasogastric decompression following abdominal operations should be used selectively.

The use of prophylactic drainage of enteric anastomoses is questionable, as it may be associated with an increased risk of anastomotic breakdown and fistula formation. In elective surgery, especially with difficult stump closure, e.g. after Polya gastrectomy, it is often prudent to create a controlled fistula rather than rely on intraperi-

TABLE 2.
Indications for surgical drainage in abdominal surgery

Decompression of viscus (e.g. duodenostomy, T-tube in common bile duct)
Large potential dead space (e.g. abdominoperineal resection, abscess cavity)
Insecure closure of hollow viscera (e.g. duodenum) – may provide an early warning of fistula
Established or potential fistulae (e.g. gastrointestinal, biliary and pancreatic)
Presence of necrotic or infected tissue (e.g. necrotising pancreatitis, infected pseudocyst, intra-abdominal abscess
Doubtful haemostasis – may provide an early warning of haemorrhage

TABLE 3.
Influence of nasogastric intubation on patient outcome after abdominal surgery

Reference	Study type	No. of patients	Type of surgery	Complications/no. of patients NGT No	Complications/no. of patients NGT Yes	Statistically significant differences in complication rates
Miller et al (1972)	PRT	90	Elective vagotomy	32/47	52/43	Chest infection and dysphagia with NGT
Olesen et al (1984)	PRT	95	Elective colorectal	50/49	49/46	None
Reasbeck et al (1984)	PRT	97	Elective/emergency upper and lower GIT	43/52	24/45	None
Meltvedt et al (1985)	PRT	118	Elective colorectal surgery	2/35	12/83	None
Bauer et al (1985)	PRT	200	Elective small and large bowel	4/100	8/100	None
Cheadle et al (1985)	PRT	200	Elective upper and lower GIT and aortic graft	29/100	48/100	Vomiting without NGT, nose and throat discomfort with NGT
Colvin et al (1986)	PRT	142	Elective colonic	20/46	39/96	None
Racette et al (1987)	PRT	56	Elective small and large bowel	32/28	60/28	Atelectasis with NGT, abdominal distention without NGT
Wolff et al (1989)	PRT	535	Elective colorectal	227/261	135/274	Abdominal distention (28%), nausea (27%), vomiting (19%) and tube replacement without NGT
Nathan and Pain (1991)	PRT	197	Elective upper and lower abdominal	62/100	62/97	None
Cheatham et al (1995)	MA	3964	Various (mixed upper and lower abdominal)	833/1986	1084/1978	Pneumonia, atelectasis and fever with routine NGT

GIT = gastrointestinal tract; MA= meta-analysis; NGT= nasogastric tube; PRT= prospective randomized trial toneal drainage. The duodenocutaneous fistula formed by a duodenal drain is easily managed, initially with suction and later with passive drainage once the amount of effluent decreases.

The benefits of tube enterostomy in the treatment of blunt or penetrating duodenal injuries are debatable. Stone and Fabian (1979) reported a decreased complication rate, especially fistula formation, whereas Ivatury et al (1985) reported higher mortality and complication rates with decompressive tube enterostomy. It is reasonable to use a nasoduodenal tube for duodenal decompression if gastrointestinal continuity is maintained and the minor duodenal injury is easily repairable. For a more extensive duodenal injury or if the closure is tenuous, a duodenostomy tube along with peritoneal suction drainage plus diversion are preferable options.

Lower gastrointestinal tract

To date, five randomized trials comparing prophylactic drainage *vs* no drainage in colorectal surgery have failed to show any significant difference in the prevention of complications or the detection of anastomotic leaks (*Table 4*). Two studies (Hoffmann et al, 1987; Johnson et al, 1989) have advised against routine drainage of colonic anastomoses because:

1. Drains hinder the migration of the omentum and adjacent viscera to seal the anastomosis
2. They evoke an inflammatory reaction which may cause anastomotic breakdown
3. They failed to provide 'early warning' in the detection of colonic anastomotic leakage.

Galandiuk and Fazio (1991), on the other hand, showed a decreased incidence of a leak with drainage of the presacral space following a low colorectal anastomosis. Lastly, a meta-analysis by Urbach et al (1999) showed that the use of a drain did not significantly affect the mortality, anastomotic leakage rate and wound infection rate, although the power of this analysis to exclude any difference was low. Of the 20 observed leaks among all four studies that occurred in patients with a drain in place, pus or enteric content actually appeared in the effluent of the existing drain in only one case (5%). In conclusion, the present data do not justify the prophylactic drainage of a colorectal anastomosis. Proximal diversion by colostomy or ileostomy seems to be a better way of avoiding complications from an anastomotic leak.

Following abdominoperineal resection, the use of suction drainage through the anterior abdominal wall is a better option than a passive drain through the perineum. The passive drain which exits either via the suture line or lateral to the incision in the perineum is associated with increased rates of wound infection and dehiscence.

Rectal trauma is usually treated either with primary repair (with or without diverting stoma) and a pelvic suction drain or a Hartmann's procedure. However, Mangiante et al (1986) found that patients following rectal gunshot injuries recovered whether or not the presacral area was drained. Nevertheless, in the absence of a randomized trial, the use of pelvic drains in rectal trauma seems justifiable to decrease the incidence of septic complications in the heavily contaminated pelvis, although the value of such drains in a minimally contaminated wound is less certain.

SOLID ORGANS

Biliary tract

In the era of open cholecystectomy, the role of subhepatic drainage after elective cholecystectomy was extensively investigated. Four randomized trials comparing active *vs* passive drainage showed that the former was preferable because of a decreased incidence of complications (*Table 5*). Furthermore, nine randomized trials comparing a drain *vs* a no drain group showed a higher incidence of pulmonary complications in the former group (*Table 6*). Brewster et al (1992) suggested

TABLE 4.
Influence of a drain on the incidence of anastomotic leaks, intra-abdominal collections and mortality rate in colorectal surgery

Reference	Study type	No. of patients D	ND	Anastomotic leaks D *vs* ND	Intra-abdominal collections D *vs* ND	Wound infection D *vs* ND	Mortality rate D *vs* ND	Statistically significant differences D *vs* ND
Hoffman et al (1987)	PRT	28	30	7% *vs* 10%	ns	14% *vs* 7%	0% *vs* 10%	None
Johnson et al (1989)	PRT	49	57	12% *vs* 10%	0% *vs* 2%	20% *vs* 17%	4% *vs* 2%	None
Sagar et al (1993)	PRT	94	51	23% *vs* 18%	12% *vs* 10%	18% *vs* 6%	9% *vs* 2%	None
Sagar et al (1995)	PRT	52	48	13% *vs* 10%	15% *vs* 6%	6% *vs* 0%	6% *vs* 6%	None
Merad et al (1999)	PRT	247	245	6.8% *vs* 6%	ns	4% *vs* 6%	3% *vs* 4%	None

D= drain; ND= no drain; ns= not stated; PRT= prospective randomized trial short-term suction drainage of the gallbladder bed after laparoscopic cholecystectomy to monitor bile leaks, although most surgeons feel that this is not warranted. However, emergency laparoscopic gallbladder surgery and exploration of the common bile duct (CBD) are reasonable indications for short-term suction drainage.

T-tube drainage of the CBD after ductal exploration remains controversial. In a randomized trial, Payne and Woods (1986) showed that primary closure of a choledochotomy in the presence of an intra-abdominal drain was a safe alternative to T-tube drainage. Two further studies (Sorensen et al, 1994; Williams et al, 1994) not only confirmed the safety of this approach but also revealed significantly reduced hospital stay. Nonetheless, T-tube placement has certain advantages which include:

1. A better control of bile leakage if it occurs
2. Minimally invasive treatment of retained stones via T-tube tract, which may be superior to endoscopic retrograde cholangiopancreatography, as it avoids damage to the ampulla.

In addition, cholangiography through the T-tube is a sensitive technique to identify unsuspected iatrogenic ductal injury and retained CBD stones. T-tube drainage following exploration of the CBD remains the standard of care because the morbidity and mortality of strictures and retained stones in the CBD far exceed that caused by T-tube placement. Furthermore, in the era of laparoscopic CBD exploration, routine T-tube placement, even in the presence of normal completion cholangiography, reflects caution on the part of surgeons. It is unlikely that the routine use of T-tubes will be abandoned by the majority of surgeons in the foreseeable future.

Liver

Routine use of abdominal drainage after liver resection is controversial. Bona et al (1994) retrospectively reviewed 51 patients who underwent major hepatic resection with abdominal drainage. The incidence of major and minor complications was 31% and 39% respectively. The authors concluded that after major hepatic resection, short-term use of abdominal drainage does not increase the incidence of postoperative complications which are related to the extent and complexity of the hepatic resection.

A French randomized trial (Belghiti et al, 1993) found a higher incidence of infected subphrenic fluid collections in the drainage group compared with the non-drainage group. However, there was no significant difference in the rate of intra-abdominal postoperative com-

TABLE 5.
Comparison between active and passive drainage groups in conventional cholecystectomy trials

Reference	Study type	No. of patients		Wound infection	Pulmonary complications	Drain site tenderness	Postoperative fever	Postoperative hospital stay
		A	P	A *vs* P	A *vs* P	A *vs* P	A *vs* P	A *vs* P
Van der Linder et al (1981)	PRT	92	92	2% *vs* 4%	1% *vs* 0%	ns	NSS	ns
Fraser et al (1982)	PRT	50	42	18% *vs* 10%	4% *vs* 24%*	44% *vs* 60%	14% *vs* 43%*	NSS
Sarr et al (1987)	PRT	67	61	1% *vs* 8%*	ns	12% *vs* 39%*	36% *vs* 64%*	NSS
Loder et al (1987)	PRT	24	18	4% *vs* 0%	ns	NSS	ns	ns

A= active drain; P= passive drain; NSS= not statistically significant; ns= not stated; PRT= prospective randomized trial. *statistically significant

TABLE 6.
Comparison between drained and undrained patients undergoing conventional cholecystectomy

Reference	Study type	No. of patients		Postoperative hospital stay	Wound infection	Intra-abdominal collection	Pulmonary complications
		D	ND	D *vs* ND	D *vs* ND	D *vs* ND	D *vs* ND
Gordon et al (1976)	PRT	50	50	NSS	14% *vs* 10%	0% *vs* 0%	14% *vs* 12%
Maull et al (1978)	PRT	100	100	SL with drainage	14% *vs* 9%	0% *vs* 0%	1% *vs* 2%
Edlund et al (1979)	PRT	50	50	NSS	0% *vs* 2%	0% *vs* 0%	2% *vs* 0%
Farha et al (1981)	PRT	81	41	NSS	1% *vs* 2%	0% *vs* 0%	23% *vs* 15%*
Budd et al (1982)	PRT	200	100	NSS	3% *vs* 0%	1% *vs* 0%	13% *vs* 9%
Truedson (1983)	PRT	158	175	SL with drainage	2% *vs* 3%	6% *vs* 2%	1% *vs* 2%
Playforth et al (1985)	PRT	78	77	NSS	10% *vs* 10%	0% *vs* 1%	13% *vs* 8%
Monson et al (1986)	PRT	54	58	ns	5% *vs* 2%	18% *vs* 2%*	18% *vs* 9%

D= drained; ND= not drained; ns= not stated; NSS= not statistically significant; PRT= prospective randomized trial; SL=significantly longer. *statistically significant

TABLE 7.
Effect of a drain on subphrenic abscess formation following splenectomy

Reference	No. of patients	Drainage		Types of drain	Subphrenic abscesses	
		Yes	No		Drained	Undrained
Daoud et al (1966)	106	48	58	Penrose/cigarette	5 (10%)	7 (12%)
Olsen and Beaudoin (1969)	584	497	87	Not mentioned	20 (4%)	2 (2%)
Cerise et al (1970)	533	295	238	Penrose	28 (9%)	1 (0.4%)
Slater (1973)	50	31	19	Not mentioned	1 (3%)	0
Pachter et al (1981)	78	55	23	Jackson Pratt/Penrose	1 (4%)	0
Ugochukwu and Irving (1985)	282	282	0	Low-pressure suction	0	2 (0.17%)
Rao (1988)	54	54	0	Open suction	6 (11%)	0
Carmichael et al (1990)	198	105	93	Jackson Pratt/Penrose	8 (8%)	1 (1%)
Total	1885	1367	518		69 (5%)	13 (2.5%)

plications after major hepatic resection in the drained *vs* the undrained groups. Another randomized trial from America (Fong et al, 1996) found no difference in the length of hospital stay, mortality, complication rate or requirement for subsequent percutaneous drainage with or without suction drainage after elective liver resection. These various trials therefore have clearly shown that prophylactic drainage after minor or major elective liver resection is of no value and should be discouraged.

TABLE 8.
Complications of drains

Foreign body effects	Haemorrhage, fistula and perforation as a result of erosion
	Obstruction of hollow viscus
	Tissue inflammation
	Bacterial surface adherence and retrograde bacterial migration
	Impaired healing of intestinal suture lines
	Tumour implantation along drain tract
Mechanical problems	Drain entrapment as a result of sutures, kinking, knotting or tissue ingrowth
	Herniation and strangulation of viscera through drain tracts
	Drain loss as a result of migration, breakage, fragmentation
	Leakage (of bile or pancreatic fluid) as a result of incomplete drain tract formation
Physiological derangements	Pain
	Postoperative pyrexia (caused by the drain)
	Fluid, electrolyte and protein loss
	Pneumoperitoneum, pneumothorax
	Surgical emphysema
	Venous air embolism
	Excessive fluid secretion
Inadequate drainage	Faulty drain positioning, kinking or obstruction
	Wrong type of drain or drainage method

Passive drains can be detrimental with limited hepatic injuries because they are more likely to cause retrograde infection. However, closed suction drains appear to reduce septic complications in severe hepatic injuries. Intraperitoneal bile collections can occur even in the presence of drains, therefore meticulous attention to surgical technique, including suturing of disrupted bile ducts, remains the most important factor in decreasing this complication.

Pancreas

There are conflicting reports regarding the role of peritoneal lavage in severe acute pancreatitis. Sump suction drainage of the peripancreatic area with or without four quadrant drainage is recommended by some surgeons after pancreatic necrosectomy. Others, however, favour repeated debridement and open drainage for infected necrotizing pancreatitis as a more effective method of reducing the mortality and morbidity because of poor drainage of solid debris through close drainage systems. Berne (1995) found that patients with pancreatic bed infection associated with severe sepsis, acute physiology and chronic health evalution (APACHE II) score >16, difficult anatomy and suspicion of extrapancreatic pathology needed operative drainage, whereas patients with mild sepsis, APACHE II score of ≤16 and good anatomy were easily managed with percutaneous drainage. Most surgeons use suction drainage of the peripancreatic area with or without irrigation following an operative debridement and remove these drains once the daily drainage volume is decreased to <30 ml/day and the drain amylase levels are normal.

The need for routine drainage after pancreatic resection is also contentious. An American study (Cullen et al, 1994) revealed the incidence of pancreatic leak to be 18% following 375 consecutive pancreaticoduodenectomies. The majority of such leaks were clinically insignificant and easily managed by intraoperatively placed suction drains. Furthermore, only a very small number of patients required percutaneous drainage or laparotomy. The routine placement of prophylactic intraperitoneal suction drains following pancreatic resection to detect an early pancreatic or biliary anastomotic leak is justifiable in the absence of any randomized trials because such leaks carry very high morbidity and mortality.

It is universally accepted that all but the most trivial traumatic pancreatic injuries should be treated with some sort of drainage. Some type of resection or diversion along with drainage is often required with serious pancreatic injuries. Passive drains result in higher complication rates and are unable to achieve adequate decompression of the high volume fluid leaks produced by the lacerated pancreatic duct following serious pancreatic injuries. Although sump drains are ideal for treating these injuries, the majority of surgeons prefer simple closed suction drains because they are easier to manage, less likely to obstruct and less likely to transmit retrograde infection.

Spleen

There is no consensus on drainage of the splenic bed following elective splenectomy. Ugochukwu and Irving (1985) concluded that the use of closed suction drainage was responsible for a low incidence of subphrenic abscess (0.17%) in a consecutive series of 282 patients undergoing elective splenectomy. However, numerous authors have strongly advised against routine drainage of the splenic bed because of a higher incidence of subphrenic abscess in the drainage group (*Table 7*). Drainage of the splenic bed following splenectomy for trauma is also associated with an increased incidence of postoperative complications, especially with concurrent gastrointestinal injuries. Most surgeons prefer prophylactic drainage of the left subphrenic space if there is suspicion or evidence of pancreatic injury or concomitant breach in the gastrointestinal tract. Both scenarios result in a high incidence of fluid collection and abscess formation. Although retrospective, the evidence favours avoidance of prophylactic drainage in an uncomplicated splenectomy.

COMPLICATIONS OF ABDOMINAL DRAINS

Complications associated with drains are numerous (*Table 8*). Important factors responsible for these complications are summarized in *Table 9*.

CONCLUSIONS

The uses of drains in abdominal surgery remains controversial. Three questions must be considered when deciding on the value of operative drainage:

1. What purpose would a drain serve if placed?
2. What type of drain(s) should be used?
3. How long should the drain be left in place?

In any surgical procedure, good haemostasis, appropriate antibiotic use and precise surgical technique with minimal tissue trauma limit the need for operative drain placement. In a situation where a drain is indicated, active drainage is preferable to passive drainage because it is associated with fewer complications. Prophylactic drainage should be practiced with caution because drains may cause more problems than they prevent. Decompressive drains should be used liberally but removed as soon as possible. Early removal of a drain decreases the incidence of some complications, including infection and pres-

TABLE 9.
Factors responsible for causing drain complications

Passive drains have a higher incidence of complications compared with active drains
The risk of complication is directly proportional to the number of drains
Drains left for a longer time period are associated with increased complication rates and are more difficult to remove because of the ingrowth of surrounding tissue
Drains in the perineum have a higher incidence of septic complications compared with those in the abdomen
Drains placed in clean procedures are associated with less postoperative infective complications compared with a dirty and septic procedure
Antibiotic prophylaxis is associated with a decreased incidence of postoperative infectious complications even in the presence of drains
An immunocompromised patient, such as one on chronic steroids or suffering from protein calorie malnutrition, is at increased risk of developing drain-associated complications

KEY POINTS

- Traditional concepts and individual surgical bias, unsupported by scientific data, too often determine current practices of surgical drainage.
- Drain usage in abdominal surgery should not be a substitute for poor surgical techniques and inadequate haemostasis.
- Active drains are better than passive drains as they are associated with fewer complications.
- Only selective use of nasogastric intubation following abdominal surgery should be encouraged.
- The use of prophylactic drainage of enteric anastomoses is questionable and lacks scientific justification.
- The prophylactic drainage of solid organs i.e. liver and spleen is associated with higher incidence of infective complications and should be practiced selectively.
- New abdominal laparoscopic procedures should not alter the indications for use of abdominal drains.

sure necrosis of adjacent structures. New abdominal laparoscopic procedures should not alter the indications for the use of abdominal drains. Casual use of drains in laparoscopic surgery therefore must be discouraged. In conclusion, the practice of surgical drainage in abdominal surgery, whether open or laparoscopic, must be based on sound surgical principles. **HM**

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