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ORIGINAL ARTICLE

The role of peri-hepatic drain placement in liver surgery: a prospective analysis

Jean M. Butte, Jan Grendar, Oliver Bathe, Francis Sutherland, Sean Grondin, Chad G. Ball & Elijah Dixon

Division of General Surgery, Service of Hepatobiliary and Pancreatic Surgery, Foothills Medical Centre, University of Calgary, Calgary, AB, Canada

Abstract

Background: The standard use of an intra-operative perihepatic drain (IPD) in liver surgery is controversial and mainly supported by retrospective data. The aim of this study was to evaluate the role of IPD in liver surgery.

Methods: All patients included in a previous, randomized trial were analysed to determine the association between IPD placement, post-operative complications (PC) and treatment. A multivariate analysis identified predictive factors of PC.

Results: One hundred and ninety-nine patients were included in the final analysis of which 114 (57%) had colorectal liver metastases. IPD (n = 87, 44%) was associated with pre-operative biliary instrumentation (P = 0.023), intra-operative bleeding (P < 0.011), Pringle's manoeuver(P < 0.001) and extent of resection (P = 0.001). Seventy-seven (39%) patients had a PC, which was associated with pre-operative biliary instrumentation (P = 0.048), extent of resection (P = 0.002) and a blood transfusion (P = 0.001). Patients with IPD had a higher rate of high-grade PC (25% versus 12%, P = 0.008). Nineteen patients (9.5%) developed a post-operative collection [IPD (n = 10, 11.5%) vs. no drains (n = 9, 8%), P = 0.470]. Seven (8%) patients treated with and 9(8%) without a IPD needed a second drain after surgery, P = 1. Resection of ≥3 segments was the only independent factor associated with PC [odds ratio (OR) = 2, P = 0.025, 95% confidence interval (CI) 1.1–3.7].

Discussion: In spite of preferential IPD use in patients with more complex tumours/resections, IPD did not decrease the rate of PC, collections and the need for a percutaneous post-operative drain. IPD should be reserved for exceptional circumstances in liver surgery.

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Correspondence

Elijah Dixon, Division of General Surgery, Faculty of Medicine, University of Calgary, EG – 26, Foothills Medical Centre, 1403-29 Street NW, Calgary, AB, Canada T2N 2T9. Tel: +1 403 944 3045. Fax: +1 403 944 1277. E-mail: elijah.dixon@albertahealthservices.ca

Introduction

The use of an intra-operative perihepatic drain (IPD) in hepatopancreatobiliary surgery has been a standard practice for many years, with the aim of improving the managment of a possible post-operative local complication.[1–4]

Liver surgery has improved dramatically during recent years as a consequence of better management of central venous pressure, intra-operative bleeding and techniques to perform a parenchimal transection. However, the role of an IPD in liver surgery remains controversial. Two single-centre randomized trials performed almost 20 years ago had different results; while one showed a higher incidence of intra-abdominal and infected collections in the drainage group of patients undergoing a minor liver resection, without differences when major liver resections were analysed;[5] the second did not show any difference in complications, mortality, or requirement for subsequent percutaneous drainage.[6] Furthermore, a higher incidence of wound infections in the drainage group was observed in a more recent trial that used the crushing clamp method to transect the liver. The drain was maintained in place for at least 3 and 4 days, respectively. Unfortunatly, these

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results may be questionable because these studies did not have the adequeate statistical power to to define if a IPD should be placed during surgery. Moreover, as the improvement in surgical techniques to transect the liver have progressed in the last years, these results may not necessarily define the current practice.

The aims of this study were to evaluate the role of IPD in liver surgery in a contemporary and prospective series. This study sought to identify variables associated with drain placement during liver surgery, to determine predictive factors of outcome and their association with perihepatic drains, and to analyse the treatment of intra-abdominal collections. This information may be relevant for the development of future prospective trials.

Patients and methods

Subjects and data collection

After approval by the Institutional Review Board at University of Calgary, Foothills Medical Centre, records of all patients who had been included in a previous prospective randomized trial were obtained from a prospective database and analysed. This trial evaluated the role of *mucomyst* after a liver resection and was conducted between 2007 and 2012. Recorded data included patient demographics, operative procedures, peri-operative outcomes and their treatments. A perihepatic *Jackson Pratt* drain was placed at the end of the surgery according to the preference of the surgeon. Patients with and without IPD were compared to determine any association with outcome and treatment. Post-operative complications were defined with the Clavien–Dindo classification.[7] A high-grade complication was defined as a complication type 3, 4, or 5 of this classification. The most severe complication defined the score of each patient.

Operative approach

Neo-adjuvant chemotherapy was utilized selectively depending on the diagnosis and presentation of disease. All patients underwent an open exploration, which included mobilization, palpation and ultrasonography of the liver. The criterion for considering that the disease was unresectable was based on the AHPBA consensus statement[8] or in the presence of extrahepatic disease, but this was evaluated patient by patient.

The extent of liver resection depended on the amount and distribution of disease and proximity to inflow and outflow pedicles at exploration. A major hepatectomy included the resection of 3 or more segments and included anatomical (right or left hepatectomy, extended hepatectomy or central hepatectomy) or non-anatomical resections. A minor hepatectomy included less than three segments of the liver. Common bile duct and vascular resection/reconstructions were performed selectively to achieve clear margins when involvement was suspected. A formal lymphadenectomy was performed depending on the primary diagnosis and extension of disease. Surgical technique was standard during the study period. This included the use of staplers, haemostatic devices and methods for a parenchymal transection (hydrojet, armonic, or aquamantys), depending on the preference of the surgeon during the surgery. The presence of cirrhosis was not a factor in the placement of a drain during surgery. Operative and peri-operative outcomes were recorded prospectively as part of the trial.

The indications for placing a post-operative drain included the presence of a fluid collection associated with signs of infection, which included the presence of clinical deterioration associated with abnormal parameters (i.e. fever and high white blood count). Patients were evaluated with images only if they presented any sign to suspect the presence of a collection. The presence of bile in the drain was defined clinically. The level of total bilirubin in the drain and blood was evaluated selectively and a value equal or higher than 3 times the serum level was considered positive. Surgical mortality was defined as death resulting from post-operative complications within 90 days of surgery.

Statistical analysis

Categorical variables were summarized using proportions, and continuous variables were expressed as the mean (±standard deviation) [for parametric data] or median (range). Characteristics of patients with and without IPD were compared using Fisher's exact test for categorical variables and Wilcoxon's signed rank test for continuous variables. An age- and sex-adjusted logistic regression to assess the influence of pre-operative American Society of Anesthesiologists (ASA) score, extent of resection and intra-operative placement of an IPD on overall post-operative complications, occurrence of post-operative collections and the need for percutaneous drain placement was performed. These factors were selected based on face validity and previous research.[5,6] All tests were two-sided and a $P < 0.05$ was considered significant. Statistical analysis was performed with SPSS version 19.0 (SPSS Inc., Chicago, IL, USA) and STATA version 12 (StataCorp LP, College Station, TX, USA).

Results

Clinical characteristics

Between 2007 and 2012, 263 patients were randomized to receive *mucomyst* after a liver resection. Sixty-four patients did not undergo a resection, whereas a resection was performed in 199 (76%) patients, who were included for analysis in this study. Clinical- and treatment-related variables for the use of IPD are shown in Table 1. Clinical and treatment variables related to PC are shown in Table 2.

Correlation between post-operative complications and drains

Patients treated with an IPD had a higher incidence of post-operative general complications [40 (46%) versus 37 (33%)], but this was not significant ($P = 0.078$). However, patients with drains had a significant number of higher score complications (type 3 and 4) [18 (20.7%) vs. 13 (11.6%)]. Moreover, a higher mortality (type 5) [4 (4.6%)] was observed in patients treated with a drain ($P = 0.008$) (Table 1).

Table 1 Comparison of clinical and treatment-related variables between patients with and without a intra-operative perihepatic drain

Clinical characteristics	Total *N* = 199 (%)	No drain *N* = 112 (%)	Drain *N* = 87 (%)	*P*
Gender				0.058
Male	119 (59.8)	60 (53.6)	59 (67.8)	
Age, years				0.800
≤60	100 (50.3)	57 (50.9)	43 (49.4)	
Mucomyst				0.800
Yes	89 (44.7)	51 (45.5)	38 (43.7)	
Diagnosis				0.070
Colorectal liver metastases	114 (57.3)	71 (63.4)	43 (49.4)	
Hepatocellular carcinoma	38 (19.1)	20 (17.9)	18 (20.7)	
Gallbladder cancer/cholangiocarcinoma	16 (8)	6 (5.4)	10 (11.5)	
Other cancer	7 (3.5)	4 (3.6)	3 (3.4)	
Benign disease	24 (12.1)	11 (9.8)	13 (14.9)	
Pre-operative biliary instrumentation				<0.021
Yes	10 (5)	2 (1.8)	8 (9.2)	
Pre-operative biliary drain				0.080
Yes	6 (3)	1 (0.9)	5 (5.7)	
ASA score				0.170
1	17 (8.5)	8 (7.1)	9 (10.3)	
2	130 (65.3)	71 (63.4)	59 (67.8)	
3	52 (26.1)	33 (29.5)	19 (21.8)	
Multiple tumours (177)				0.500
No	99 (55.9)	58 (58)	41 (53.2)	
Type of resection				0.002
Right lobe	60 (30.5)	44 (40)	16 (18.4)	
Left lobe	81 (41.1)	41 (37.3)	40 (46)	
Bilateral	56 (28.4)	25 (22.7)	31 (35.6)	
Resection >1 segment				0.067
Yes	167 (85.2)	88 (80.7)	79 (90.8)	
Major liver resection				<0.011
Yes	90 (45.9)	41 (37.6)	49 (56.3)	
Length of surgery (median, minutes)				<0.001
≤194	99 (50.3)	69 (62.2)	30 (34.9)	
Blood loss (ml)				<0.011
≤500	120 (61.5)	75 (68.4)	45 (51.7)	
Pringle maneouvre				<0.001
Yes	106 (56.1)	46 (43.4)	60 (72.3)	
Post-operative complication				0.078
Yes	77 (38.7)	37 (33)	40 (46)	
Clavien type complication				0.008
0	122 (61.3)	75 (67)	47 (54)	
1	15 (7.5)	8 (7.1)	7 (8)	
2	27 (13.6)	16 (14.3)	11 (12.6)	
3	19 (9.5)	9 (8)	10 (11.5)	
4	12 (6)	4 (3.6)	8 (9.2)	
5	4 (2)	0	4 (4.6)	
Infectious complication				0.300
Yes	35 (17.6)	17 (15.2)	18 (20.7)	
Post-operative collections				0.470
Yes	19 (9.5)	9 (8)	10 (11.5)	
Post-operative drain				0.600
Yes	16 (8)	9 (8)	7 (8)	

ASA, American Society of Anesthesiologists.

Table 2 Uni and multivariate analyses of clinical and treatment-related variables stratified by post-operative complications

Clinical characteristics	Total *N* = 199 (%)	No complications *N* = 122 (61%)	Complications *N* = 77 (39%)	*P* univariate	OR	95 CI	*P* multivariate
Gender				0.400		0.478–1.679	0.731
Male	119 (59.8)	70 (57.4)	49 (63.6)				
Female	80 (40.2)	52 (42.6)	28 (36.4)		0.896		
Age, years				0.700		0.514–1.714	0.837
≤60	100 (50.3)	60 (49.2)	40 (51.9)				
>60	99 (49.7)	62 (50.8)	37 (48.1)		0.94		
Diagnosis				0.300			
Colorectal liver metastases	114 (57.3)	75 (61.5)	39 (50.6)				
Hepatocellular carcinoma	38 (19.1)	21 (17.2)	17 (22.1)				
Gallbladder cancer/cholangiocarcinoma	16 (8)	7 (5.7)	9 (11.7)				
Other cancer	7 (3.5)	5 (4.1)	2 (2.6)				
Benign disease	24 (12.1)	14 (11.5)	10 (13)				
Biliary instrumentation				<0.041			
Yes	10 (5)	3 (2.5)	7 (9.1)				
No	189 (95)	119 (97.5)	70 (90.9)				
Biliary drain				<0.031			
Yes	6 (3)	1 (0.8)	5 (6.5)				
No	193 (97)	121 (99.2)	72 (93.5)				
ASA score				0.500	1.032	0.595–1.788	0.911
1	17 (8.5)	13 (10.7)	4 (5.2)				
2	130 (65.3)	77 (63.1)	53 (68.8)				
3	52 (26.1)	32 (26.2)	20 (26)				
Multiple tumours (177)				1			
No	99 (55.9)	61 (56)	38 (55.9)				
Yes	78 (44.1)	48 (44)	30 (44.1)				
Type of resection				0.006			
Right lobe	60 (30.5)	44 (36.1)	16 (21.3)				
Left lobe	81 (41.1)	51 (41.8)	30 (40)				
Bilateral	56 (28.4)	27 (22.1)	29 (38.7)				
Resection >1 segment				0.500			
No	29 (14.8)	20 (16.4)	9 (12.2)				
Yes	167 (85.2)	102 (83.6)	65 (87.8)				
Resection ≥3 segments				0.008			
No	106 (54.1)	75 (61.5)	31 (41.9)				
Yes	90 (45.9)	47 (38.5)	43 (58.1)		2	1.09–3.666	0.025
Length of surgery (median)				0.019			
≤194	99 (50.3)	69 (57)	30 (39.5)				
>194	98 (49.7)	52 (43)	46 (60.5)				
Blood loss				1			
≤500	120 (61.5)	73 (61.3)	47 (61.8)				
>500	75 (38.5)	46 (38.7)	29 (38.2)				
Pringle manoeuvre				0.5			
No	83 (43.9)	54 (45.8)	29 (40.8)				
Yes	106 (56.1)	64 (54.2)	42 (59.2)				
Drain placement				0.078		0.899–3.045	0.106
No	112 (56.3)	75 (61.5)	37 (48.1)				
Yes	87 (43.7)	47 (38.5)	40 (51.9)		1.654		

Table 3 Multivariate analysis of variables associated with post-operative collections and post-operative drain placement after a liver resection

	Post-operative collection			Post-operative drain		
	OR	95% CI	*P*	OR	95% CI	*P*
Age >60 years	0.744	0.275–2.012	0.560	0.826	0.282–2.415	0.727
Gender (female)	0.915	0.312–2.683	0.871	0.855	0.267–2.737	0.792
ASA score	1.816	0.736–4.48	0.195	1.701	0.542–4.511	0.286
Drain placement	1.566	0.564–4.348	0.389	1.027	0.341–3.092	0.962
Resection of ≥3 segments	1.638	0.585–4.591	0.348	1.677	0.551–5.101	0.362

CI, confidence interval; OR, odds ratio; ASA, American Society of Anesthesiologists.

Nineteen patients (9.5%) developed a post-operative collection, with a similar incidence between patients with (n = 10, 11.5%) and without (n = 9, 8%) PD, P = 0.470. Seven (8%) patients treated with and 9 (8%) treated without an IPD needed a second drain after surgery (P = 1). Evidence of bile in the drain was observed in 9 patients, 4 (4.6%) with a drain and 5 (4.5%) without a drain, P = 1. Eight out of 9 patients with a bilious drainage needed a new drain after surgery (only a patient treated with a drain placed during the surgery did not require a post-operative drain). Seven out of 10 patients without bile in the drain required a second drain. Four patients without a drain placed during the surgery but treated with a drain after surgery had non-bilious drainage in this fluid. No complications related to drain placement during surgery were observed. The placement of an IPD did not decrease the placement of a post-operative drain, when it was needed (Table 1).

Multivariate analysis

The multivariate analysis showed that the only factor associated with post-operative complications was the resection of ≥3 segments of the liver (major resection) [odds ratio (OR) = 2, 95% confidence interval (CI) 1.0–3.66, P = 0.025] (Table 2). In contrast, this study did not find independent factors to predict a post-operative collection or the possibility of having a second drain after surgery (Table 3).

Discussion

The use of prophylactic drains in abdominal surgery has been a standard practice for several years to manage possible post-operative complications.[2,4,9] In spite of some authors having suggested that the presence of a drain may be related to the genesis of a complication,[10] that assumption has never been proven. In contrast, it is known that the major risk factor for developing a complication is the type of abdominal surgery. Systematic reviews and meta-analyses have evaluated the role of prophylactic drains in gastrointestinal surgery concluding that many colorectal, gastric and general surgery (appendectomy and cholecystectomy) operations may be performed safely without a drain, because they do not reduce post-operative complications.[11–14] This recommendation has been less robust for liver surgery, because of the lack of strong evidence or conflicting results.[15–18]

The concept of prophylactic drains in hepatopancreatobiliary surgery is evolving,[19] but mainly based on single-centre trials or retrospective studies.[20–25] Nevertheless, the decision to place a peri-hepatic drain during liver surgery depends on other factors such as the techniques for transecting and controlling intra-operative bleeding or the presence of an anastomosis. Four single-centre randomized trials have supported the idea of '*no drains*' in hepatic surgery.[5,6,26,27] Three were performed more than 10 years ago and have been criticized for their methodology. Belghiti *et al.*[5] randomized 81 patients, observing a higher rate of infected collections in patients treated with a drain, but the morbidity and mortality were similar. In another trial, Fong *et al.*[6] evaluated 120 patients, observing similar outcomes between patients with and without drains. However, patients without a peri-hepatic drain had a higher possibility of getting another drain after surgery (18 versus 8%). A more recent study from Liu *et al.*[26] in cirrhotic patients demonstrated higher rates of post-operative wound, septic and overall complications in drained patients, resulting in a significantly longer hospital stay. Abdominal drainage was an independent risk factor for post-operative morbidity. A meta-analysis from these three studies did not show any difference in infected intra-abdominal collections, biloma or pulmonary complications.[11]

The present study included data that were collected prospectively from a randomized trial representing accurate and contemporary information. Moreover, this population is similar than those that usually undergo a liver resection, as the majority had metastases from colorectal cancer and a median age was 60 years.[2] A perihepatic drain was placed during the operation in half of the population (44%) and was associated with more complex resections. The incidence of general post-operative complications was not significantly different, but patients with drains had a higher score complication and mortality. This finding seems to be related to the extent of surgery and not necessarily to the presence of a drain as the multivariate analysis confirmed.

The present study suggests that peri-hepatic drains should not be used as routine practice after a liver resection. This is based on that less than 10% of patients developed a post-operative collection and the presence of a drain did not decrease the incidence. Based on these findings, 90% of the patients in this series would not benefit from the use of a drain following surgical resection. Moreover, the risk of having a new drain after surgery did not decrease when a drain was placed during surgery. The proportion of patients who were treated with a drain during surgery but required a second drain after surgery (8%) was similar to Fong's trial, but the incidence of a second drain in patients who did not have a drain placed during surgery was lower (8 versus 18%). The ideal scenario would be to identify a subgroup of patients who could eventually benefit from a drain. However, this study failed in identifying predictor factors of post-operative collections or the possibility of having a second drain after surgery.

This analysis has some limitations. First, as this is not a randomized or a multicentric study, the question of whether a drain is adequate for patients who undergo a liver resection cannot be answered. However, these findings support previous information that suggests that an IPD may be avoided in most patients at the moment of liver surgery, and does not change the concept that a peri-hepatic drain is not necessary for every patient. Second, these results may not represent other experiences of centres with less surgical volume and with other risk factors for developing a post-operative collection, but single-centre and selection bias, like the preference for methods of liver transection or the use of staplers, may also be related with these results. Finally, the subgroup of patients who underwent more complex surgery (i.e. hilar cholangiocarcinoma) may benefit from a prophylactic drain placed during the operation.

In conclusion, this study showed that an IPD is not necessary for every patient after a liver resection. Resection of more than 3 segments was the only independent factor associated with a post-operative complication. Factors associated with post-operative collections or the necessity for a second drain were not identified. A multicentric randomized trial would be the best way to answer this question.

Conflicts of interest

None declared.

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