Postoperative cardiothoracic ratio on the first postoperative day is a predictor of postoperative pleural effusion drainage following hepatectomy

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Abstract

Purpose

Although several preoperative risk factors for postoperative pleural effusion (POPE) after hepatectomy have been reported, few postoperative predictors have been investigated. We aimed to examine risk factors for clinically relevant POPE (CR-POPE) and whether cardiothoracic ratio (CTR) could be a predictive factor.

Methods

Participants in this retrospective investigation comprised 382 patients who underwent hepatectomy between January 2012 and December 2021. Perioperative characteristics that were considered potential risk factors for CR-POPE were evaluated. CR-POPE was defined as having undergone thoracentesis or thoracic drain placement.

Results

Patients were divided into a CR-POPE group ($n = 38$; 10.0%) and a non-CR-POPE group ($n = 344$; 90.0%). The CR-POPE group showed significantly higher intraoperative infusion volume ($P < 0.001$) and lower intraoperative urine volume ($P = 0.015$). In multivariate analysis, abdominal incision with a reversed L-shape or inverted T-shape (odds ratio [OR] = 3.07, $P = 0.023$], estimated blood loss > 772 g (OR = 2.71, $P = 0.049$), diaphragm incision (OR = 8.31, $P = 0.008$), major postoperative complications excluding CR-POPE (OR = 7.99, $P < 0.001$), intraoperative infusion volume per body weight > 80 mL/kg (OR = 4.80, $P = 0.007$) and CTR on postoperative day (POD)1 > 59.0% (OR = 4.34, $P = 0.001$) were all independently associated with occurrence of POPE.

Conclusion

We clarified risk factors for CR-POPE following hepatectomy. The occurrence of CR-POPE might be predictable from the CTR on POD1.

Introduction

Liver resection is a widely accepted curative treatment for malignant and benign diseases of the liver. Several postoperative complications after liver resection have been reported, such as intra-abdominal hemorrhage, intra-abdominal infection, bile leakage, ascites effusion, and pleural effusion (PE).

Postoperative pleural effusion (POPE) is one of the most common complications after liver resection. The incidence of POPE following hepatectomy has been reported as 18–71% [1–3]. The clinical presentation of POPE varies widely, from mild asymptomatic cases to severe cases with respiratory failure. POPE is rarely fatal, but sometimes necessitates thoracentesis or thoracic drain placement, as POPE is an important cause of postoperative hypoxia, which may result in liver failure [1]. POPE can thus prolong hospitalization and increase costs [2]. Furthermore, occurrence of POPE not only affects short-term outcomes, but can also delay postoperative rehabilitation and subsequent disease treatment. In patients with hepatocellular carcinoma, POPE has been reported as an independent risk factor for recurrence and patient death [2]. Identification of risk factors for POPE is therefore important.

Cardiothoracic ratio (CTR) is a simple value to evaluate heart size from chest radiographs [4]. CTR has been found to offer a useful prognostic factor in several diseases. In cardiovascular disease, CTR is used to indicate cardiomegaly and is associated with heart failure [5, 6]. A higher CTR is associated with higher mortality among patients on hemodialysis [7, 8]. Higher CTR also indicates pulmonary venous congestion [9]. However, to best of our knowledge, no association between CTR and POPE after hepatectomy has been reported.

We investigated risk factors for POPE and examined whether CTR could allow early detection of POPE.

Material And Methods

Patients

Participants in this retrospective study comprised 382 consecutive patients who had undergone hepatectomy (including both with/without biliary reconstruction followed by extrahepatic bile duct resection) for malignant or benign disease between January 2012 and December 2021 at Ehime University Hospital. Donors and recipients of liver transplantation as well as patients who had received placement of an intraoperative thoracic drainage tube due to accidental thoracotomy were excluded. Data on background characteristics, perioperative laboratory data, perioperative clinical data, pathological findings, and CTR were collected from medical records. This protocol was reviewed and approved by the institutional ethics committee of Ehime University Hospital in 2022. All participants, including retrospectively registered patients or their guardians, verbally consented to the use of their medical information for scientific research (approval no. EUH2205008).

Operative Procedures And Perioperative Management

Indications for surgery and surgical procedures were decided by a multidisciplinary team. Mobilization of the liver was performed only when required to resect a tumor safely. Patients essentially underwent intermittent hepatic pedicle occlusion during parenchymal dissection. The liver parenchyma was transected using a Cavitron ultrasonic surgical aspirator (Integra Lifesciences Corporation, Plainsboro, NJ, USA) and electric cautery equipped with channels for water dripping. Vessels that appeared in transected sections were generally ligated. Stumps of hepatic or portal veins were sutured using non-absorbable monofilament suture or divided using a linear stapler. One or two closed suction drainage tubes were usually placed close to the cut surface of the liver Winslow’s foramen according to the preference of the operator. Regarding postoperative management, patients with hypoxia or dyspnea for whom PE could be drained safely under computed tomography (CT) or ultrasound (US) guidance was one of the criteria for PE drainage. Asymptomatic hypoxia or assumption of worsened dyspnea with > 500 mL of PE on CT or US was another criterion. In-out balance was calculated as the infusion volume minus urine volume minus drain output on postoperative day (POD)1. Albumin was transfused when serum albumin value was < 2.5mg/dL in early postoperative phase or to maintain appropriate blood pressure.

Postoperative complications were defined according to the Clavien–Dindo classification, and events of grade III or above were defined as major complications. POPE of grade III (thoracentesis or thoracic drain placement) or above was defined as clinically relevant POPE (CR-POPE) [10].

Calculation Of Ctr And Ct Volumetry For Pope

CTR was calculated as the ratio of the maximal horizontal diameter of the heart to the maximal diameter of the thoracic wall on a chest radiograph (Fig. 1). Preoperative chest radiographs were taken in a standing position within 1 month before surgery. Postoperative chest radiographs in a supine position were taken in the operating room immediately postoperatively and in the intensive care unit the next morning.

Postoperative chest and abdominal CT were taken around 1 week after surgery in most patients. Estimated POPE volume was calculated using 3-dimensional imaging software (SYNPASE VINCENT medical imaging system; Fujifilm Medical, Tokyo, Japan) (Fig. 2). Estimated POPE volume was measured before thoracentesis in the CR-POPE group.

Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS®) for Windows® (v.24.0; SPSS, Chicago, IL, USA). Longitudinal trends between CTR and estimated POPE volume were calculated using Spearman ρ correlations. Continuous variables were compared using Mann–Whitney U tests and are presented as medians with ranges. Optimal cut-offs for CTR and other risk factors were determined using receiver operating characteristic (ROC) curve analysis or standard cut-offs. Categorical variables were compared using χ^2 or Fisher’s exact tests and are presented with ratios. Significant variables on univariate analyses were included in multivariate analyses with stepdown logistic regression and likelihood tests. Regression models were calibrated using Hosmer–Lemeshow tests. Significance was defined at the level of $P < .05$.

Results

Univariate analysis for CR-POPE

Of the 382 patients who underwent hepatectomy, 38 patients (10.0%) had CR-POPE. Thirty-seven patients had right-sided POPE and one had left-sided POPE. Median time from hepatectomy to drainage of POPE was 6 days (range, 2–35 days). Median volume of pleural fluid drained on the day of thoracentesis was 732 mL (range, 160–2,150 mL). Patient characteristics are summarized in Table 1. The CR-POPE group showed higher preoperative total serum bilirubin level. Preoperative CTR, preoperative cardiac function and respiratory function did not differ significantly between groups.

Table 1
Preoperative factors

	Non-CR-POPE *n* = 344	CR-POPE *n* = 38	*P*
Sex, male	254 (73.8%)	29 (76.3%)	0.741
Age, years	70 (26–89)	72 (41–80)	0.793
Body mass index, kg/m^2	23.8 (15.4–39.8)	23.8 (17.2–32.0)	0.740
Comorbidities			
Diabetes mellitus	111 (32.3%)	9 (23.7%)	0.295
Hypertension	194 (56.4%)	23 (60.5%)	0.626
Chronic kidney disease	16 (4.7%)	3 (7.9%)	0.290
Cardiovascular disease	50 (14.5%)	6 (15.8%)	0.836
Previous hepatectomy	66 (19.2%)	3 (8.6%)	0.086
Chemotherapy	76 (22.1%)	5 (13.1%)	0.201
RFA	44 (12.8%)	3 (7.9%)	0.601
TACE	86 (24.1%)	6 (15.8%)	0.249
Blood biochemistry			
Hemoglobin, g/dL	12.9 (7.9–19.5)	12.6 (7.9–16.2)	0.938
Platelet, 10^4/μL	18.8 (4.5–64.1)	17.6 (8.0-56.5)	0.567
Total bilirubin, mg/dL	0.6 (0.2–22.8)	0.8 (0.3–10.0)	0.006
Albumin, g/dL	3.8 (2.5–5.2)	3.8 (2.6–4.7)	0.606
Creatinine, mg/dL	0.80 (0.20–8.68)	0.82 (0.41–6.16)	0.451
PT-INR	1.00 (0.83–2.21)	1.00 (0.84–1.29)	0.555
ICGR15, %	12 (1–48)	10 (2–25)	0.06
Echocardiography			
LVDd, mm	45.6 (28.2–65.0)	26.9 (40.4–56.0)	0.105
LVDs, mm	28.0 (17.0–46.0)	29.0 (20.0-40.1)	0.203
LVEF, %	66.7 (44.2–83.4)	66.2 (43.5–78.0)	0.707
LAD, mm	36.0 (17.2–51.0)	36.1 (25.1–59.0)	0.980

	Non-CR-POPE $n = 344$	CR-POPE $n = 38$	P
Spirometry			
%VC, %	108 (39–151)	102 (65–129)	0.062
%$FEV_{1.0}$, %	76 (27–100)	76 (54–81)	0.663
Child-Pugh			0.647
A	320 (93.0%)	34 (89.5%)	
B	23 (6.7%)	4 (10.5%)	
C	1 (0.3%)	0 (0.0%)	
CTR, %	47.0 (35.0-60.5)	48.6 (40.1–67.1)	0.065
RFA, radiofrequency ablation; TACE, transcatheter arterial chemoembolization; PT-INR, prothrombin time-international normalized ratio; ICGR15: indocyanine green retention rate at 15 min; LVDd, left ventricular diameter at end-diastole; LVDs: left ventricular diameter at end-systole; LVEF: left ventricular ejection fraction; LAD: left atrial dimension; %VC: vital capacity percentage; %FEV1.0: forced expiratory volume in 1 s as a percentage of forced vital capacity; CTR, cardiothoracic ratio; CR-POPE, clinically relevant postoperative pleural effusion.			

In terms of intraoperative variables, type of abdominal incision, prolonged duration of hepatic pedicle occlusion, higher estimated blood loss, greater frequency of red blood cell transfusion, higher infusion volume, lower urine volume, greater number of resected liver segments, biliary reconstruction, and diaphragm incision were all associated with occurrence of CR-POPE (Table 2).

Table 2
Intraoperative factors

	Non-CR-POPE *n* = 344	CR-POPE *n* = 38	*P*
Abdominal incision			< 0.001
Laparoscopy	95 (27.6%)	0 (0.0%)	
Median	33 (9.6%)	1 (2.6%)	
Reversed L-shape	151 (43.9%)	27 (71.1%)	
Inverted T-shape	66 (18.9%)	10 (26.3%)	
Hepatic pedicle occlusion time, min	53 (0-240)	61 (0-274)	0.020
Operation time, min	388 (87 – 1,094)	427 (170–990)	0.372
Estimated blood loss per BW, g/kg	6.9 (0-61.1)	21.3 (1.2-109.2)	< 0.001
Red blood cell transfusion	93 (27.0%)	26 (68.4%)	< 0.001
Intraoperative infusion volume per BW, mL/kg	63.2 (15.7-163.7)	109.2 (54.5-264.4)	< 0.001
Intraoperative urine volume per BW, mL/kg	8.8 (0-58.2)	13.6 (0-64.4)	0.016
Surgical site on S7 or S8	154 (44.8%)	20 (52.6%)	0.393
Number of resected segments	2 (0–6)	3 (0–6)	< 0.001
Biliary reconstruction	33 (9.6%)	14 (36.8%)	< 0.001
Diaphragm incision	14 (4.1%)	5 (13.2%)	0.031

BW, body weight; CR-POPE, clinically relevant postoperative pleural effusion.

Regarding postoperative variables, the CR-POPE group showed a higher CTR on both POD0 and POD1, higher infusion volume on POD1, higher urine volume on POD1, prolonged duration of hospitalization and a greater frequency of major postoperative complications excluding POPE (Table 3).

Table 3
Postoperative factors

	Non-CR-POPE *n* = 344	CR-POPE *n* = 38	*P*
Hospital stays, days	13 (3-163)	40 (7-164)	< 0.001
Major postoperative complications excluding POPE	43 (12.5%)	25 (65.8%)	< 0.001
Bile leakage	18 (5.2%)	7 (18.4%)	0.007
Intra-abdominal hemorrhage	3 (0.9%)	3 (7.9%)	0.015
Intra-abdominal infection	10 (2.9%)	8 (21.1%)	< 0.001
Portal vein thrombosis	0 (0%)	2 (5.2%)	0.010
Liver failure	2 (0.6%)	4 (10.5%)	0.001
CTR on POD0, %	54.9 (41.6–67.6)	56.4 (45.4–65.0)	0.045
CTR on POD1, %	55.5 (42.7–66.7)	59.3 (49.4–67.8)	< 0.001
Infusion volume on POD1 per BW, mL/kg	38.5 (8.5–95.2)	49.0 (18.7–74.3)	< 0.001
Urine volume on POD1 per BW, mL/kg	25.6 (0-102.1)	17.3 (0-52.3)	< 0.001
In-out balance on POD1 per BW, mL/kg	9.3 (-62.1-60.1)	20.2 (14.1–50.2)	< 0.001
Pathological findings			0.004
Hepatocellur carcinoma	174 (50.6%)	14 (36.8%)	
Cholangiocarcinoma	48 (14.0%)	14 (36.8%)	
Metastatic tumor	106 (30.8%)	8 (21.1%)	
Other	16 (4.7%)	2 (5.3%)	
Cirrhosis of resected liver, F4	60 (17.4%)	8 (21.1%)	0.581

Cirrhosis was pathologically diagnosed according to the Inuyama classification.

CTR, cardiothoracic ratio; POD, postoperative day; CR-POPE, clinically relevant postoperative pleural effusion.

Correlation Between Ctr On Pod1 And Estimated Pope Volume

Estimated POPE volume was evaluated from CT images among 250 patients at a median of 7 postoperative days (range, 1–16 days). Figure 3 shows scatter plots of CTR on POD1 and estimated POPE volume. Estimated POPE volume correlated with CTR on POD1 (r = 0.175; 95% confidence interval [CI], 0.055–0.290; $P = 0.005$).

Calculation Of Optimal Ctr Cut-off

The optimal cut-off was determined using ROC curve analysis (Fig. 4). Area under the ROC curve for CTR on POD1 was 0.678 (95%CI, 0.580–0.775) and the most appropriate cut-off was determined to be 59.0. This value offered 57.9% sensitivity and 80.5% specificity.

Multivariate Analysis For Cr-pope

Factors that showed significant correlations with CR-POPE on univariate analyses were entered into the multivariate analysis (Table 4). On multivariate analysis, abdominal incision with a reversed L-shape or inverted T-shape (odds ratio [OR], 3.07; 95%CI, 1.17–8.04; $P = 0.023$), estimated blood loss > 772 g (OR, 2.71; 95%CI, 1.01–7.28; $P = 0.049$), diaphragm incision (OR, 8.31; 95%CI, 1.75–39.45; $P = 0.008$), major postoperative complications excluding POPE (OR, 7.99; 95%CI, 3.13–20.41; $P < 0.001$), intraoperative infusion volume per body weight (BW) > 80 mL/kg (OR, 4.8; 95%CI, 1.55–14.86; $P = 0.007$) and CTR on POD1 > 59.0% (OR, 4.34; 95%CI, 1.77–10.66; $P = 0.001$) were identified as independent risk factors for CR-POPE (Table 4).

Table 4
Uni- and multivariate analyses to identify predictors of clinically relevant postoperative pleural effusion

	Univariate		Multivariate	
	Odds ratio (95% CI)	*P*	Odds ratio (95% CI)	*P*
Total bilirubin < 0.9 mg/dL	2.60 (1.28–5.31)	0.007	0.58 (0.09–3.66)	0.560
Abdominal incision (reversed L-shape or inverted T-shape)	3.48 (1.63–7.43)	0.001	3.07 (1.17–8.04)	0.023
Hepatic pedicle occlusion time > 33 min	1.95 (0.95–3.99)	0.067		
Estimated blood loss > 772 g	9.37 (4.27–20.58)	< 0.001	2.71 (1.01–7.28)	0.049
Red blood cell transfusion	5.82 (2.82–12.02)	< 0.001	1.74 (0.66–4.60)	0.266
Resected Segments > 3	3.23 (1.63–6.41)	0.001	0.77 (0.22–2.73)	0.684
Biliary reconstruction	5.50 (2.60–11.6)	< 0.001	0.58 (0.09–3.66)	0.560
Diaphragm incision	3.57 (1.21–10.54)	0.021	8.31 (1.75–39.45)	0.008
Major postoperative complications excluding POPE	13.46 (6.41–28.28)	< 0.001	7.99 (3.13–20.41)	< 0.001
Intraoperatieve infusion volume per BW > 80 mL/kg	11.44 (4.87–26.86)	< 0.001	4.80 (1.55–14.86)	0.007

	Univariate		Multivariate	
In-out balance on POD1 per BW > 20 mL/kg	3.79 (1.91–7.52)	< 0.001	2.20 (0.91–5.31)	0.081
Pathological findings, cholangiocarcinoma	3.60 (1.74–7.44)	0.001	1.19 (0.43–3.28)	0.739
CTR on POD1 > 59.0%	5.40 (2.70-10.83)	< 0.001	4.34 (1.77–10.66)	0.001
POPE, postoperative pleural effusion; BW, body weight; CTR, cardiothoracic ratio; POD, postoperative day; CI, confidence interval.				

Discussion

POPE is one of the most common postoperative complications after liver resection. Previous studies have reported various risk factors for POPE, including age, body mass index, chronic obstructive pulmonary disease, resection site of liver, resected liver weight, operative time, and transfusion [2, 3, 11, 12]. The present study revealed abdominal incision, blood loss, diaphragm incision, and intraoperative infusion volume as independent risk factors for CR-POPE. CTR on POD1 was identified as an independent predictor. Moreover, estimated POPE volume using CT volumetry correlated with CTR on POD1. CT volumetry for POPE is a novel approach that allows continuous quantification of volume.

Generally, PE is classified as exudative (due to imbalances in hydrostatic or oncotic pressures) or transudative (inflammatory) effusion based on the pathophysiology [13, 14]. POPE following coronary artery bypass surgery is classified as exudative, but POPE following hepatobiliary surgery is uncertain. PE after liver resection might have a dual etiology of both hypoalbuminemia with cirrhosis and direct inflammatory responses to the thoracic cavity. Clinically, most POPE tends to arise in the right-sided pleural cavity. Risk factors including abdominal incision, resection site, incision in the diaphragm to reach the liver, and tumor invasion to the diaphragm, indicated the influence of local inflammation. Another strongly associated factor, was postoperative complications excluding POPE, such as bile leakage or cut-end abscess, which demonstrate local or systemic inflammation, leading to secondary POPE. However, since biochemical data for PE were lacking, it remains unclear whether POPE is a result of other complications or a sign of complications, or both.

Postoperative hypoalbuminemia is also reportedly associated with POPE [15]. We therefore investigated the impact of hemodynamics on CR-POPE and whether CTR could predict CR-POPE. Excessive infusion volume has been reported to worsen postoperative pulmonary function [16, 17]. Surgical invasion has direct effects on fluid retention. Plasma volume decreases with general anesthesia alone [18]. Under such conditions of intraoperative hemodynamics, fluid distributes into the interstitium. A Danish multicenter randomized trial showed that a higher volume of intraoperative fluid infusion resulted in sodium retention and weight gain for 2–3 days after surgery, then declined [19]. This accumulation of fluid and delayed clearance may cause excessive intravascular volume loading, leading to pulmonary edema and PE. Postoperative enlargement of the CTR is a sign of overloading and cardiomegaly. In the present study, the CR-POPE group showed a significantly higher infusion volume and lower urine volume intraoperatively. Furthermore, infusion volume correlated with both estimated POPE volume and CTR. This demonstrated that an excessive fluid balance resulted in POPE. Perioperative fluid management should be administered appropriately according to blood loss [20]. However, if the operation takes a longer time, total infusion volume will be correspondingly higher. In hepatobiliary surgery, bleeding from the liver parenchyma sometimes requires massive infusion or transfusion. Attention must be paid to the infusion volume, particularly in patients with poor cardiac, respiratory, or renal function or the elderly.

Adjusting postoperative infusion volume and early administration of diuretics could inhibit excessive overloading. On the other hand, goal-directed fluid therapy that requires perioperative fluid restriction has become widespread, and is being trialed for liver resection [21–23]. Transition of surgery and anesthesia might affect the occurrence of postoperative complications. Actually, the present cohort showed a lower incidence of CR-POPE than previous reports [1–3].

In the present study, abdominal incision was an independent factor. Recent progress in minimally invasive surgery has led to increases in laparoscopic surgery [24]. Conversely, the occurrence of comorbidities has decreased in laparoscopic surgery [25]. The higher estimated blood loss, transfusion and biliary reconstruction in the CR-POPE group may support secondary POPE due to other postoperative complications. In fact, postoperative complications were independently associated with CR-POPE.

The CTR is a well-established value in the clinical setting for evaluating cardiac morphology radiologically [4]. Rayner et al. reported that CTR on cardiac radiographs correlated with left ventricular mass on echocardiography [26]. Previous studies have reported the prognostic utility of the CTR. A larger CTR could be a predictive marker of sudden death in patients with chronic heart failure and long-term survival rate in patients with hemodialysis [5, 6]. Those studies demonstrated that hemodynamics had an effect on CTR. Further, a larger CTR is a prognostic factor for short-term postoperative outcomes in cardiac surgery [27, 28]. However, no investigations with non-cardiac surgery have been conducted and this is the first to show an impact of CTR on postoperative outcomes.

This retrospective study showed several limitations. Imaging conditions for chest radiography might vary depending on the status of the patient. Postoperative abdominal pain alters respiratory functions. Patients with chronic obstructive pulmonary disease often have a smaller CTR, whereas patients with chronic heart failure have a larger CTR. The advantage of CTR measurement is that this simple method can be applied using chest radiographs. Several advanced imaging modalities have emerged recently, such as CT, magnetic resonance imaging, and radioisotope imaging [29]. However, radiographs cannot replace these options because of the convenience, speed, and low exposure. Radiographs can be taken anywhere using mobile equipment without patient transfer. Although the rate of increase in CTR from pre- to postoperatively is also useful, here we offer a use for postoperative CTR on POD1 with clinical utility. In the present study, the properties of PE using pleural fluid were not examined and further investigations should be conducted in the future.

Conclusion

The present study revealed CTR > 59.0% is one of the risk factors of CR-POPE following hepatectomy. Larger CTR may facilitate appropriate postoperative management.

Declarations

Authors' Contributions: AS and KS contributed to the study conception and design. NF, MS, MU, TN, TU, KT, KS, KO, and YT performed surgeries and collected data. AS and KS wrote the first draft of the article. KO and YT contributed to the review and critical revision of the article. All authors have approved the final version of the manuscript.

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Figures

Fig. 1

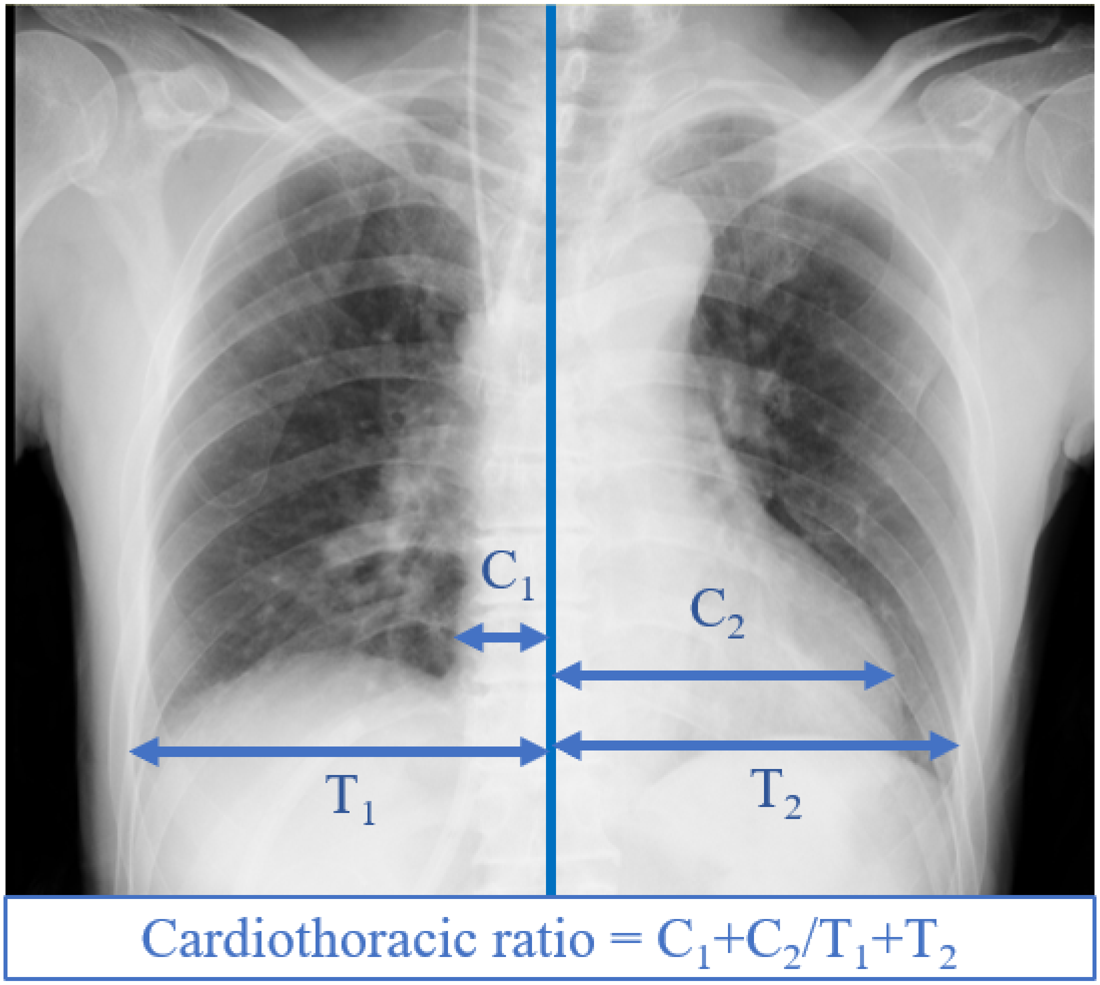

Figure 1

Cardiothoracic ratio was calculated as the ratio of the maximal horizontal diameter of the heart (C1 plus C2) to the maximal diameter of the thoracic wall (T1 plus T2) on a chest radiograph.

Fig.2

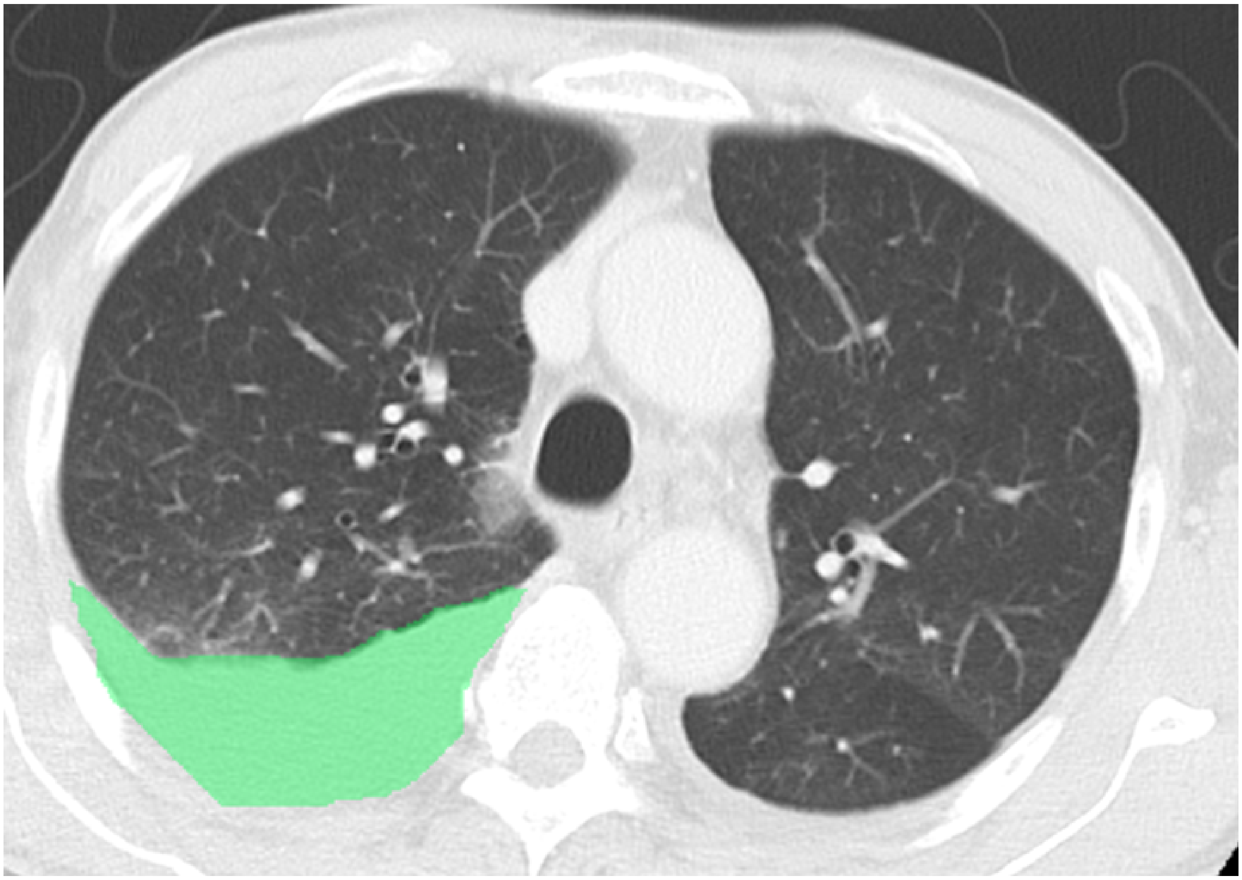

Figure 2

Computed tomography images were transferred from the Picture Archiving and Communication System (PACS) to the SYNPASE VINCENT medical imaging system. We traced the border of pleural effusion using the free-ROI manual method on axial images.

Fig.3

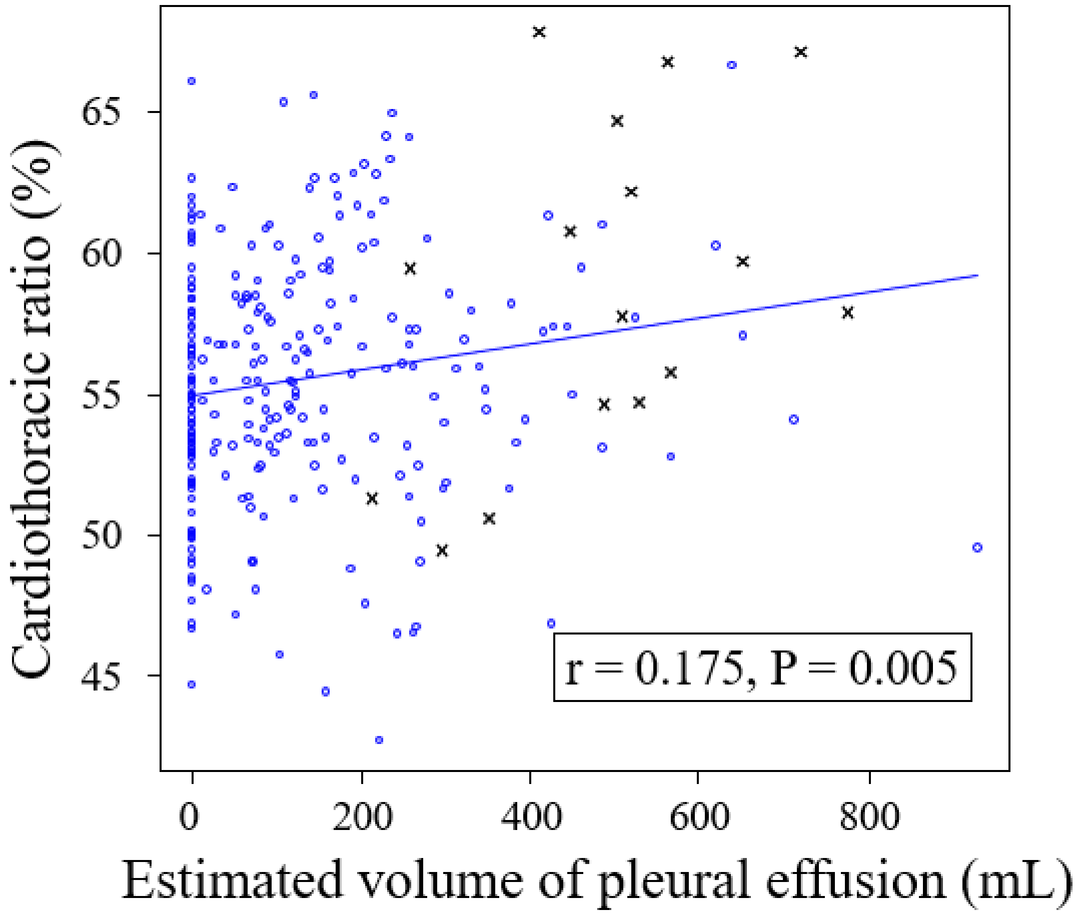

Figure 3

Scatter plot of estimated pleural effusion (PE) volume. Estimated PE volume was calculated using computed tomography (CT) volumetry (Fig. 1). Postoperative CT was performed around 1 week after surgery. In the clinically relevant postoperative PE (CR-POPE) group, estimated PE volume was evaluated before thoracentesis. The CR-POPE group is shown as cross marks and the non-CR-POPE group as circles. Positive correlations are evident between amount of PE and cardiothoracic ratio.

Fig. 4

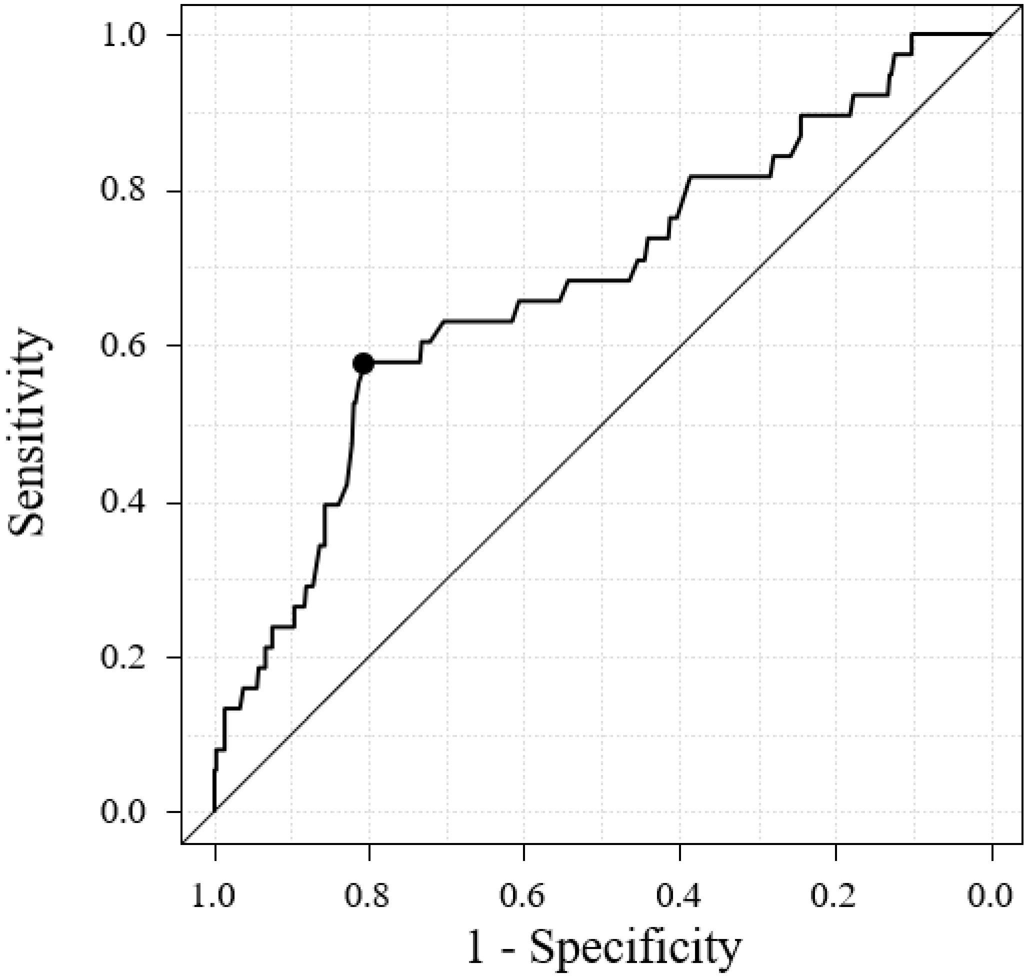

Figure 4

Receiver operating characteristic (ROC) curve analysis of cardiothoracic ratio. ROC curve analysis estimates a cardiothoracic ratio of 59.0% as the optimal cut-off for predicting postoperative pleural effusion.