



## Letter to Editor

# The high complexity major liver resection by Thunderbeat with the Pringle maneuver and infra-hepatic inferior vena cava clamping



Dear Editor,

In addition to conventional major or minor classification in liver resection (LR), recently, a complexity classification with 3 categories (low, medium, or high) according to its technical difficulty was proposed and validated.<sup>1–3</sup> The high complexity major LR, both major LR and those classified under high complexity classification, is one of the most challenging procedures in hepatobiliary surgery. We described the outcomes of the high complexity major LR by Thunderbeat® (TB) (Olympus Medical Systems Corp., Tokyo, Japan) with the Pringle maneuver and infra-hepatic inferior vena cava (IVC) clamping.

Of 79 patients undergoing LR between July 2013 and July 2019 at our institution, we reviewed six patients who underwent this procedure (Table 1). Following the Pringle maneuver and infra-hepatic IVC clamping, the transection of the liver parenchyma was started with TB under symmetric stay sutures on the hepatic edges. During parenchymal transection, only the pedicles that were equal or

larger than 3rd branches of Glissonean pedicles or main branches of major hepatic veins were ligated and divided, the other smaller ones were generally sealed with TB. To evaluate the safety and rapidity of this procedure, we compared the parenchymal transection time (PTT), estimated blood loss (EBL), and postoperative major complications (PMC) defined as Clavien-Dindo (CD) classification<sup>4</sup>  $\geq 3a$  with nine patients who underwent medium or high complexity open major LR by the basic procedure, i.e. LR by the clamp-crushing and/or the CUSA with supplemental use of Harmonic Scalpel within same periods. PTT indicated the duration recorded from the beginning of the parenchymal resection to the removal of the en-bloc specimen of liver. The postoperative liver dysfunction was assessed based on Balzan 50–50 criteria.<sup>5</sup>

Six patients underwent extended right hepatectomy with hepaticojunostomy (n = 3), anatomical middle hepatectomy (n = 1), and right trisectionectomy (n = 1) or extended left hepatectomy (n = 1) with IVC resection and reconstruction. The median PTT and EBL was 18 min and 1420 ml. Two patients experienced PMC.

**Table 1**  
Characteristics and outcomes of patients.

Patient #	1	2	3	4	5	6
<b>Age, (years)</b>	76	67	73	74	65	62
<b>Gender</b>	Woman	Man	Man	Woman	Man	Man
<b>BMI (kg/mm<sup>2</sup>)</b>	22.7	26.3	21.7	24.1	15.6	16.7
<b>Diagnosis</b>	HCC	CRLM with central biliary invasion	Perihilar cholangiocarcinoma	Perihilar cholangiocarcinoma	HCC	CRLM
<b>RPVE</b>	No	Yes	Yes	Yes	No	No
<b>Operation</b>	Anatomical middle hepatectomy	Extended right hepatectomy and hepaticojunostomy	Extended right hepatectomy and hepaticojunostomy	Extended right hepatectomy and hepaticojunostomy	Right trisectionectomy and IVC reconstruction	Extended left hepatectomy and IVC reconstruction
<b>PTT (min)</b>	45	16	17	13	27	19
<b>OD (min)</b>	260	596	458	371	217	209
<b>EBL (mL)</b>	1380	2730	2395	1460	1050	540
<b>BT</b>	No	Yes	Yes	Yes	Yes	No
<b>LWR (g)</b>	342	940	714	436	800	274
<b>Surgical margin</b>	Negative	Positive	Negative	Negative	Negative	Negative
<b>ICU stay (days)</b>	6	2	5	3	1	1
<b>LOS (days)</b>	19	68	128	60	7	8
<b>PMC (CD <math>\geq 3a</math>)</b>	No	Hepaticojunostomy failure (CD3a)	Heparin-induced bleeding (CD3b)	No	No	No
<b>Postoperative liver dysfunction</b>	No	No	No	No	No	No
<b>Survival/ (months)</b>	Alive/41	Alive with recurrence/34	Alive/28	Alive/27	Alive/4	Alive/4

BMI: body mass index, HCC: hepatocellular carcinoma, CRLM: colorectal cancer liver metastasis, RPVE: right portal vein embolization, IVC: inferior vena cava, PTT: parenchymal transection time, OD: operation duration, EBL: estimated blood loss, BT: blood transfusion, LWR: liver weight removed, ICU: intensive care unit, LOS: length of hospital stay, PMC: postoperative major complications, CD Clavien-Dindo.

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One patient developed hepaticojejunostomy failure requiring re-peritoneal drainage by paracentesis (CD3a) and another developed postoperative bleeding requiring exploratory laparotomy postoperative day (POD) 3 (CD3b). This patient received continuous administration of 10,000 units of heparin intravenously by 24 h from POD 1 and presented with clear, bloody fluid discharge from a drainage tube at POD 3. All patients are currently alive with (n = 1) or without recurrence (n = 5) with a median follow-up of 27.5 months. PTT (mean  $\pm$  SD) in the TB group was significantly shorter:  $22.8 \pm 10.8$  compared to  $79.1 \pm 49.8$  min in the basic group ( $p = 0.010$ ). There was no significant difference in terms of EBL ( $1592 \pm 753$  vs.  $1863 \pm 1378$  mL,  $p = 1.000$ ) and PMC (33 vs. 22%,  $p = 0.634$ ), respectively.

In summary, TB with the Pringle maneuver and infra-hepatic IVC clamping is feasible and seems to offer the combination of rapidity, simplicity, and safety during high complexity major LR. However, the clinical benefits and the inclusion criteria for major and/or high complexity LR need to be clarified from more big, robust and valid evidence.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at

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