Indocyanine green positive staining using hyperselective portal vein angiographic approach for laparoscopic anatomical liver resection

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BACKGROUND

Determining the boundary of anatomical liver resection is challenging. Indocyanine green (ICG) fluorescence guidance has become a promising technique in the past decade. However, the success rate of laparoscopic positive staining by direct portal vein (PV) puncture is low, even in hands of well experienced experts. To overcome these obstacles, we developed this ICG positive staining through hyperselective PV angiographic approach to improve the reproducibility.

NOVEL TECHNIQUE

According to the preoperative 3D simulation of liver anatomy, the planned anatomical hepatectomy was decided after considering the tumor location and the surrounding subsegmental PV branches.

In the hybrid operation room (Artis Zeego, Siemens Healthineers), after general anesthesia and aseptic preparation for laparoscopic hepatectomy, vascular access to the PV system was established through percutaneous transhepatic puncture of PV branch in segment 5 or 6 under ultrasound guidance.

Individual subsegmental PV branches chosen before surgery were accessed by angiographic technique. The corresponding tributaries of these PV branches were confirmed by intraoperative computed tomography after injecting contrast medium to these PV branches directly. The relationship between the tumor and the surrounding PV tributaries was reevaluated to confirm the resection margin. Finally, diluted ICG was slowly infused into the chosen PV subsegmental branches one by one to complete the positive staining.

Then the surgical team took over and started to perform laparoscopic anatomical hepatectomy according to the boundary between the stained and nonstained area.

RESULT

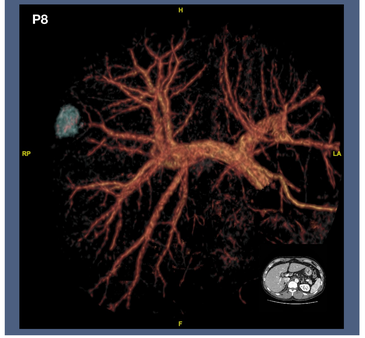
Date May 2019 - Feb 2023 | **Institution** Far Eastern memorial hospital

Characteristics		Characteristics		Characteristics	
Age (n=29)		**Puncture PV (n=29), no. (%)**		**Type of resection (n=29), no. (%)**	
Median (range), y	61 (26-79)	P3	1 (3.4%)	Sectionectomy	5 (17.2%)
Sex (n=29), no. (%)		P5	12 (41.4%)	Bisegmentectomy	1 (3.4%)
Male	22 (75.9%)	P6	16 (55.2%)	Segmentectomy	8 (27.6%)
Female	7 (24.1%)	**ICG dilution (n=28)**		Subsegmentectomy	10 (34.5%)
Disease (n=29)		Median (range), mg/ml	0.0125 (0.005-0.025)	Segmentectomy & Subsegmentectomy	1 (3.4%)
HCC	25 (86.2%)	**Total ICG dose (n=27)**		Sectionectomy & Subsegmentecfoy	3 (10.3%)
CRLM	1 (3.4%)	Median (range), mg	1 (0.25-2)	Central hepatectomy	1 (3.4%)
ICC	1 (3.4%)	**Procedure time**		**Operation time (n=29)**	
Others	2 (6.9%)	Median (range), mins	130 (65-260)	Median (range), mins	265 (110-520)
Tumor location (n=29)		**Stain result (n=27), no. (%)**		**Estimated blood loss (n=29)**	
S5, S8, S5/8	14 (48.3%)	Satisfactory	25 (92.6%)	Median (range), ml	350 (100-2200)
S6, S7, S6/7	12 (41.4%)	Suboptimal	1 (3.7%)	**Postoperative hospital stay (n=29)**	
S7/8	2 (6.9%)	Over stain	1 (3.7%)	Median (range), days	6 (4-28)
S4568	1 (3.4%)				

HCC: hepatocellular carcinoma; CRLM: colorectal cancer liver metastasis; ICC: intrahepatic cholangiocarcinoma; PV: portal vein; ICG: indocyanine green

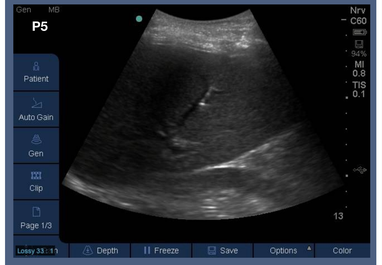
1 Preoperative work up

3D volume-rendering images with a fusion of the enhanced tumor and the portography after dynamic contrast-enhanced CT



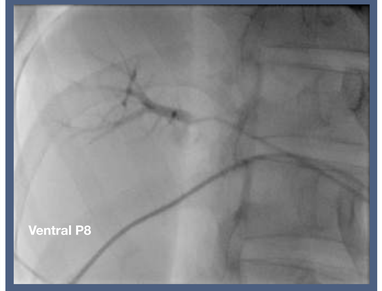
2 PV system access

Percutaneous transhepatic puncture of selective PV branch under real-time ultrasound guidance



3 Selective cannulation

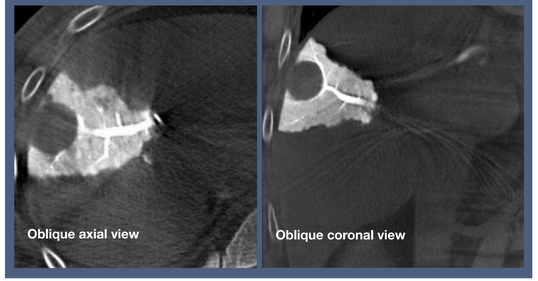
Approach the target portal pedicle by injection of contrast medium and portography



4 Cone beam CT

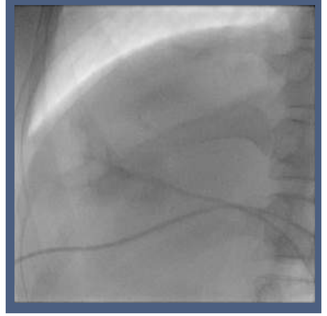
Cone beam CT with an injection of the diluted contrast medium into the target portal pedicle, which demonstrated the perfusion defect tumor and the adequate surrounding enhanced liver parenchyma

Reevaluate the relationship between the tumor and the surrounding PV tributaries to confirm of the safe resection margin



5 Diluted ICG infusion

Pulsatile manual injection of the diluted ICG solution (0.0125mg/mL) into target portal pedicle under the monitor of the fluoroscopy to avoid regurgitation



6 Stain result

Fluorescent image under laparoscopic camera
Satisfactory stain
Adequate resection margin of the specimen

