

Surgical Technique

Extended Right Hepatectomy for Hilar Bile Duct Carcinoma using the Modified Liver Hanging Maneuver

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Atsushi Nanashima, Syuuichi Tobinaga, Takafumi Abo, Takashi Nonaka, Shigekazu Hidaka, Hiroaki Takeshita, Terumitsu Sawai, Takeshi Nagayasu

Division of Surgical Oncology, Nagasaki University Graduate School of Biomedical Sciences, 1-7-1, Sakamoto, Nagasaki, 8528501, Japan

Short title: Liver hanging for right trisectionectomy

Correspondence to: Atsushi Nanashima,

15 Division of Surgical Oncology, Nagasaki University Graduate School of Biomedical Sciences, 1-7-1 Sakamoto, Nagasaki 852-8501, Japan.

Tel: +81-95-819-7304, Fax: +81-95-819-7306

E-mail: a-nanasm@nagasaki-u.ac.jp

Summary

To achieve complete extended right hepatectomy or trisectionectomy for a Bismuth type IV hilar bile duct carcinoma, we propose the application of Belghiti's liver hanging maneuver (LHM) using a small nasogastric tube. This small nasogastric tube was placed in the cut plane: the top of the tube was placed between the hepatic veins. The tube was placed along the border between the left lateral sector and Spiegel's caudate lobe and the bottom of the tube was placed at the left side of the umbilical Glissonian pedicle. Hepatic parenchyma was transected using a vascular sealing device. Hepatic transection was always targeted to the tube and, eventually, a cut line of left hepatic ducts remained. We report the case of a 76-year-old female and an 83-year-old female with widely extended hilar bile duct carcinomas showing Bismuth type IV. Applying the modified LHM for extended right hepatectomy, the cut planes were easily and adequately obtained in patients with hilar bile duct carcinoma.

Key Words: Hilar bile duct carcinoma; Right hepatectomy; Liver hanging maneuver

INTRODUCTION

Hilar bile duct carcinomas (HBDC) often extend widely and right and left hepatic ducts were found to be severely isolated in Bismuth type IV [1, 2]. In such cases, extended right hepatectomy or trisectionectomy was found to be necessary for complete resection [3]. These
5 hepatectomies are technically difficult for a trainee; therefore, application of hepatic transection would be necessary to obtain an adequate cut plane and to reduce transection time and blood loss. Application of the liver hanging maneuver (LHM) proposed by Belghiti et al. [4] for various anatomic resections has been reported recently [5, 6] and this technique can be applied for HBDC as well [7]. We also previously applied LHM for anatomic resections [8]
10 and, as described herein, we attempted modified LHM for extended right hepatectomy combined with resection of hepatic ducts in 2 HBDC patients.

Cases

Case 1) An 83-year-old female had an HBDC mainly extending to the right hepatic ducts,
15 but the hepatic duct in segment 4 could be preserved (**Figure 1**). Hepatic function was evaluated as Child-Pugh A, indocyanine green retention rate at 15 min (ICGR15) was 7% and the permitted resected liver volume for resection calculated according to the results of ICGR15 [9] was 74%. The right liver was already 50% atrophic; therefore, extended right hepatectomy was scheduled without preoperative percutaneous transhepatic portal vein
20 embolization (PTPE). Case 2) A 76-year-old female had an HBDC extending to the bile ducts in the right paramedian and lateral sector and the left hepatic duct including branches of segment 4 (**Figure 2**). Hepatic function was evaluated as Child-Pugh A, and indocyanine green retention rate at 15 min (ICGR15) was 16%. Right trisectionectomy was scheduled. The estimated resected volume of the right liver was 72% and the permitted liver volume was
25 62%. Therefore, PTPE in the right liver was planned before hepatectomy. At 5 weeks after

PTPE, the planned extended right hepatectomy was performed because of atrophy of embolized lobe (63%).

Technical aspects of the procedure

5 The patients underwent a J-shaped laparotomy (upper median plus right-side transverse incision to the 10th intercostal space) in the supine position. We initially exposed the bifurcations of the right hepatic vein (RHV), middle hepatic vein (MHV), left hepatic vein (LHV) and the anterior surface of the vena cava. Mobilization of the left lateral sectors of the liver was avoided to ensure blood supply from the surrounding ligament and to avoid liver rotation. Contrary to the original Belghiti's LHM [4], the retrohepatic space on the anterior wall of the vena cava was not completely dissected. The space between the RHV and the MHV was first dissected using a right-angled clamp. From the same space, the space with loose connective tissue below the trunk of MHV and LHM was dissected using a right-angled clamp for the renal artery to make a tunnel below the trunk. In case 1 of extended right hepatectomy, the cranial tip of a tube was placed between RHV and MHV and the tube was passed through this tunnel. This tube was still placed at the boundary between left lateral section and Spiegel lobe along the veno-portal ligament, the so-called Arantius ligament. The bottom of the tube was fixed at the left side of the umbilical Glissonian pedicle (**Figure 3**). In case 2 of the right trisectionectomy, the top of the tube was still passed through MHV and LHV, and the following technique was the same as in case 1 (**Figure 3**). To resect the extrahepatic bile duct, the lower bile duct was cut at the supra-pancreatic edge with pathological confirmation of tumor exposure at the cut end. At hepatic hilum, right hepatic artery and portal vein were initially cut.

Hepatic transection was performed using a combination of the crush clamping method and a vessel-sealing device (LigaSure PreciseTM, Covidien, Boulder, CO) during intermittent

occlusion of hepatic inflow (15-min occlusion, 5-min de-clamping). Tubes were always pulling up during transection and the direction of transection was always targeted toward the hanging tube. Transection to the anterior aspect of the vena cava was easily performed under the hanging tube. During transection, left Glisson's pedicles were hung together as shown in

5 **Figure 4.** After preparation of LHM, the retrohepatic space of the caudate lobe was completely dissected by cutting of short hepatic veins. In case 1, when the transection was achieved beyond MHV, transection was only targeted toward the hanging tube. Eventually, the remnant bile duct was cut at the planned site. Finally, RHV was cut using a vascular stapler (ENDOPATH ETS-Flex45 Endoscopic Articulating Linear Cutters, ATW45, Ethicon

10 Endo-Surgery, Cincinnati, OH). In case 2, the portal trunk was resected owing to tumor invasion and reconstruction between the left portal vein and the main trunk was undertaken. Then, the small Glissonian branches in segment 4 were divided prior to transection and the umbilical Glisson's pedicle was pulled to the left side by turning over. The bottom of the tube was replaced between this Glisson's pedicle and hepatic parenchyma by Kokudo's

15 repositioning technique (10). Then, the hepatic transection was performed by LHM and the remnant bile duct was cut at the planned site. Finally, MHV and RHV were also cut using the vascular stapler. The adhesive space between tumor and vessels was carefully dissected. The total transection time and blood loss were 44 and 40 minutes and 850 and 700 ml in cases 1 and 2, respectively. No red blood cell transfusion was necessary.

DISCUSSION

In major liver resections for HBDC, the key markers for transection lines are the hepatic veins and Glisson's pedicles [6]. As described above, LHM is a useful procedure for hepatectomy applying anatomical architecture of the liver [4-7]; therefore, it is applicable for various anatomical hepatic resections. We have already reported that modified LHM for trisectionectomy of the liver [12] and repositioning the hanging tube between liver parenchyma and Glisson's pedicles was possible. In a major hepatectomy, mobilization of the remnant liver would be limited as much as possible to avoid tumor dissemination by liver rotation and postoperative dislocation of the remnant liver [6]. LHM appears adequate to resolve these problems and the surgeon can always target the hanging tube and cut an adequate plane once the target of resection is established [4, 6].

In cases of HBDC that necessitate resection of the extrahepatic bile duct, LHM has not yet been applied because of the complexity of this hepatectomy in comparison with hepatectomy for liver tumors. Recently, Korean reports showed the feasibility and usefulness of LHM for left hepatectomy with resection of the whole caudate lobe [7]. Although it has not been well clarified whether the appropriate resection could be achieved or not, surgical records might show improvement. We also studied left hepatectomy with caudate lobe resection using LHM and observed good feasibility at this stage (data has been submitted). In comparison with left hepatectomy, right hepatectomy for HBDC might be easier because the target of hepatectomy, which relates to the boundary of the remnant liver and the Spiegel lobe, could be clearly defined. Therefore, we considered that LHM could be appropriately applied in this hepatectomy.

Previous reports revealed that transection time and blood loss were reduced [6, 8, 13] because the appropriate cut plane could be easily determined owing to the stability of the targeted position due to the hanging tube. When the present modified LHM was applied, the

target of hepatectomy could always be obtained. For a hepatectomy trainee, this procedure is very useful to guide the cut plane. Furthermore, preparation for this LHM is much easier than that for the original LHM because there is no need to pass through the entire retrohepatic space [4, 6]. In these two cases, we could determine the cut planes without any hesitation
5 until the end and, as a result, red cell blood transfusion was not necessary.

In summary, the present study indicates that modified LHM could be applied for extended right hepatectomy or trisectionectomy with bile duct resection in hilar bile duct carcinoma and could be considered a key operative technique for a hepatobiliary trainee.

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Figure legends

FIGURE 1: CT finding of a hilar bile duct carcinoma occupying the right liver and left main hepatic duct (arrow). Right portal vein was also infiltrated by the tumor. Bile duct in
5 segments 2-4 was not involved.

Figure 2: Percutaneous transhepatic cholangiography shows finding of a hilar bile duct carcinoma widely extending the right and left hepatic ducts including the hepatic duct in segment 4 (B4). Right hepatic bile ducts (RHBD) were widely infiltrated. Only bile duct in
10 the segment 2 and 3 (B23) would be secured.

Figure 3: Schematic view of the modified LHM. A) The top of the tube was placed between the right and middle hepatic ducts for the extended right hepatectomy to secure the middle hepatic vein in case 1. B) The top of the tube was replaced between the middle and left
15 hepatic veins for right trisectionectomy in case 2. The tube was placed along the border between left lateral sector and the Spiegel lobe, and the bottom of the tube was placed adjacent to the left of the umbilical Glissonian pedicle.

Figure 4: Intraoperative view of liver hanging. The bottom of the tube placed at the target
20 lesion was always fixed during hepatic transection. A thick arrow shows a gallbladder bed and a thin arrow shows the left portal vein adjacent to the umbilical portion.

Figure 1

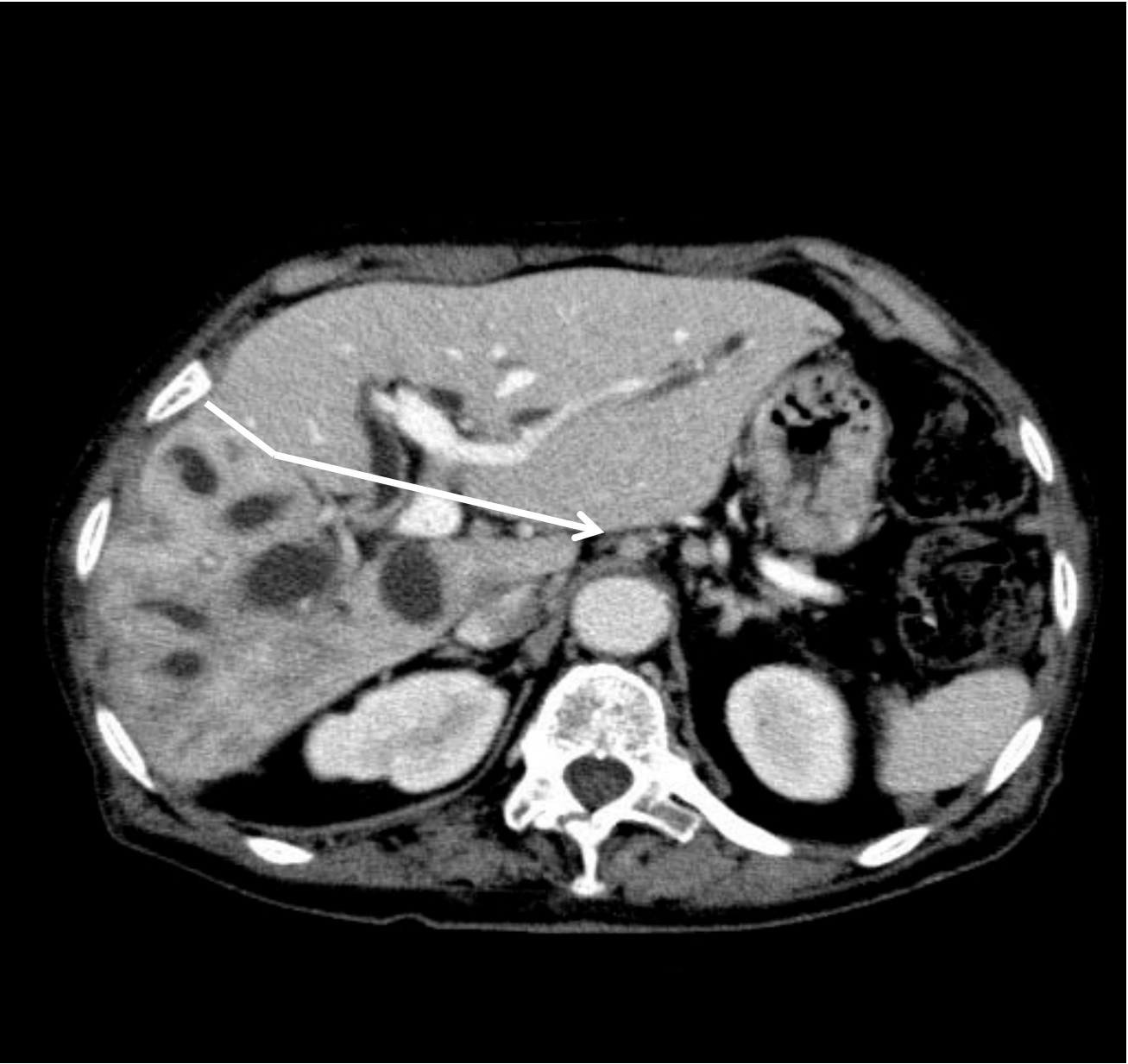


Figure 2

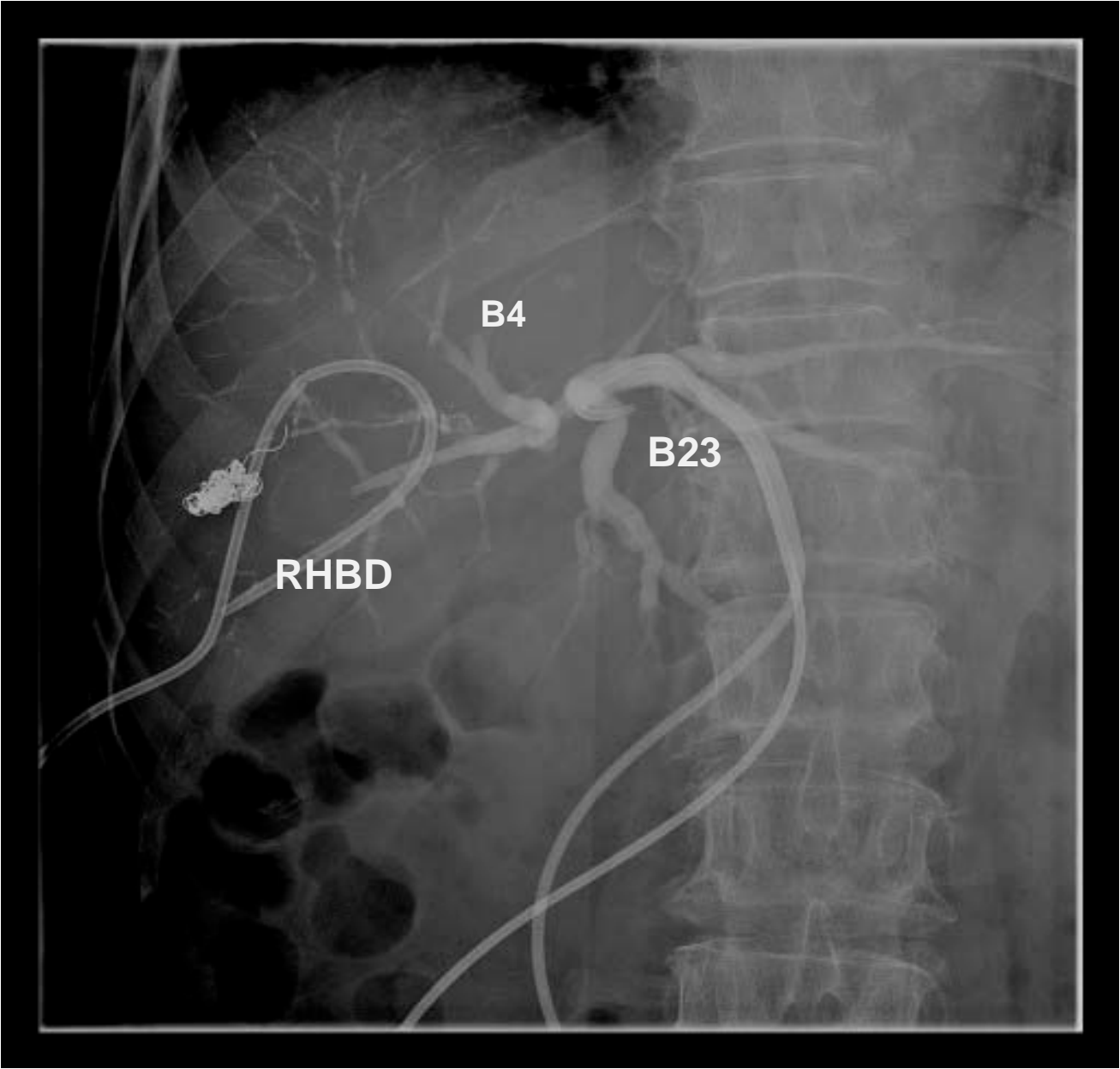


Figure 3

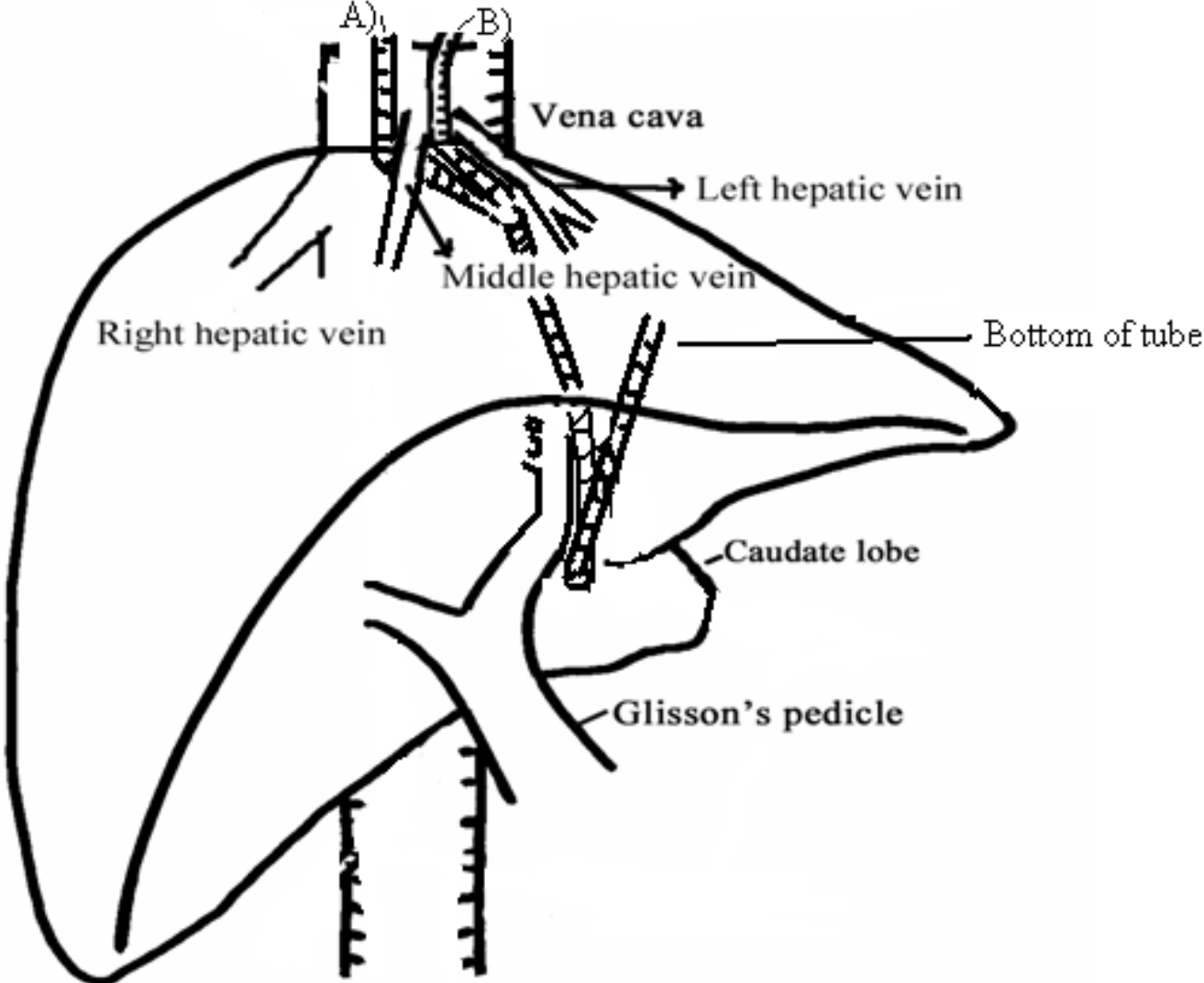


Figure 4

