Original article

Topography Of Short Hepatic Veins And Interface Veins For Safe Tunneling During Hanging Maneuver Of Liver

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Abstract

Introduction: During hanging maneuver liver resection, a tunnel is created at the interface of the liver and Inferior venacava (IVC). Gap between the middle and right hepatic vein is known as Fossa venacava. A gap between the Inferior right hepatic vein and the Caudate vein is known as a Vein gap. The Fossa venacava and Vein gap provide a safe plane for the insertion of forceps during tunneling. The aim of this study is to determine the topography of this safe plane.

Methods: A cross-sectional study was done. Twenty livers were used in our study. Major hepatic veins, distance of Vein gap, Fossa venacava, and each vessel present at the interface between liver and IVC was measured by a Vernier caliper. All the collected data was entered and analyzed by using Statistical Package for Social Sciences version 20 (SPSS-20).

Results: The average length of retro hepatic IVC was 49.5±10.5 mm and the diameter of 25.6±4.4 mm. The inferior right hepatic vein was present in 60% of cases while the Caudate vein was present in 85% of cases. Fossa venacava had an average distance of 12.3±3.46 mm and the Vein gap was 18.9±7.1 mm.

Conclusion: While tunneling between IVC and the liver, Fossa venacava could be as small as 4.6 mm. The shortest distance of the Vein gap could be as small as 5.8 mm. The intermediate course of forceps insertion is safer than the right or left course.

Keywords: Hanging maneuver; Hepatectomy; Liver; short hepatic veins

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Introduction

Conventionally, liver resection is done by removing the liver and detaching it from Inferior Venacava (IVC) by ligating each interface vessels that directly drain into IVC.[1] This conventional approach leads to rotation of hepatoduodenal ligament causing ischemia of remnant liver, dissemination of tumor, and avulsion of hepatic veins. During large tumors or dense lateral adhesion of liver, reflecting liver away is technically difficult. To address such problems, anterior approach liver resection is utilized and hanging maneuver liver resection eases the procedure of anterior approach.[2,3]

For hanging maneuver in liver resection a retro-hepatic tunnel is created at the interface between liver and IVC. Through this tunnel, an elastic tape is passed which serves as a pulley in retracting liver downward. While creating this tunnel, there are multiple vessels that arise in the interface of liver and IVC. So, there is always a risk of Injuring these vessels while tunneling.[4] A detailed anatomical knowledge of retro-hepatic IVC and short hepatic veins are necessary for surgeons before performing hanging maneuver.

Right hepatic vein (RHV), Middle hepatic vein (MHV) and Left hepatic vein (LHV) are the three major hepatic veins that drain into IVC. Most of the time middle hepatic vein forms a common trunk with LHV.[5]

On the right side, there may be a Middle right hepatic vein (MRHV) and Inferior right hepatic vein (IRHV) and on the left side, there is a Caudate vein (CV) and multiple tiny Short hepatic veins (SHV). MRHV, IRHV, CV, and SHV arise at the interface of the liver and IVC so we collectively call them Interface veins. These interface veins will appear along the course of tunneling and there is always a risk of bleeding when inserting the forceps.[5]

There is a space between the middle and right hepatic vein which provides a potential space for inserting forceps. This space is called Fossa venacava.[6] Along the course of tunneling the interface vessels appear. The major Interface vessels are Caudate vein on left side and inferior right hepatic vein on right side. Forceps should be inserted between IRHV and Caudate vein. A horizontal distance between IRHV and Caudate vein provides a safe gap which is known as a Vein gap or tunneling gap or free zone.[6-8]

Hepatocaval ligament (Makuuchi ligament) arises between the liver and the lateral edge of IVC. Right hepatic vein is invested by this ligament. While exposure of RHV, this ligament is to be taken down.[9]

The study of retro hepatic IVC relevance for hanging maneuver liver resection is being published in various countries. Our aim of the study is to find out the detail anatomy of interface veins; SHV, MRHV, IRHV, CV, find out safe plane for tunneling and distance of Fossa venacava. It will a guide a surgeon for tunneling during hanging maneuver, useful in anterior approach liver resection.

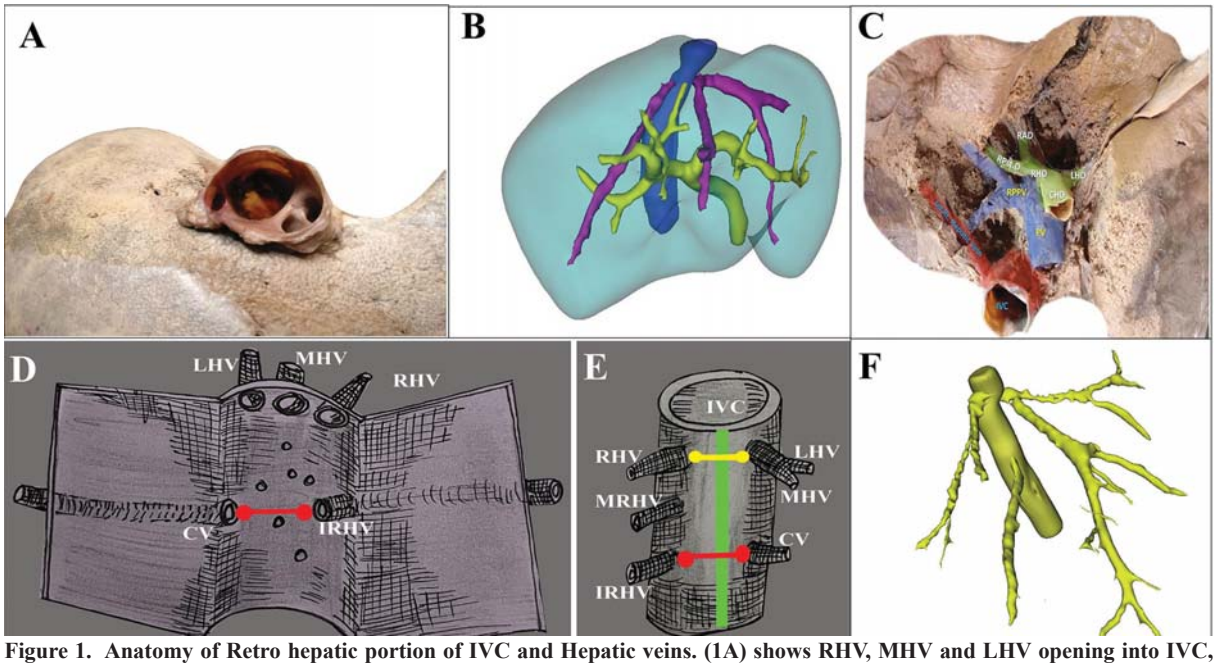

Figure 1. Anatomy of Retro hepatic portion of IVC and Hepatic veins. (1A) shows RHV, MHV and LHV opening into IVC, (1B) shows 3d reconstructed image from CT- Scan of a patient where MHV and LHV have a common trunk. (1C) shows the cadaveric image with IRHV draining to IVC, (1D) shows an illustration of IVC, where the posterior wall of IVC is incised vertically in the midline. It shows the CV and IRHV opening. A red line shows a gap between CV and IRHV. This gap is known as the Vein gap. (1E) shows a hand illustration of Hepatic veins that drain into IVC. The yellow line shows a gap between MHV and RHV known as Fossa venacava whereas the red line shows a gap between CV and IRHV which is known as the Vein gap. A vertical green line shows the safe course of forceps insertion that pass through the Vein gap and Fossa venacava. (1F) shows the 3d reconstruction image from a CT-Scan of the patient. Here we can see the Right Middle hepatic vein (RMHV) with a significant diameter that origins at the midline of IVC that may be injured during tunneling.

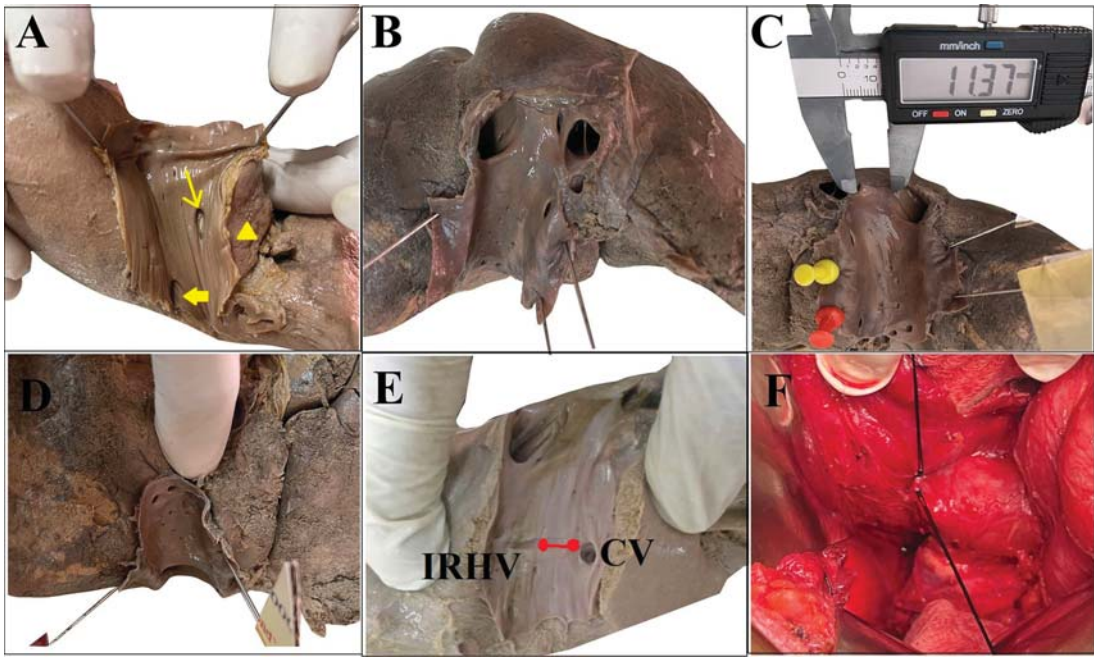

Figure 2. Cadaveric and intraoperative anatomy of Retro hepatic IVC and hepatic veins that drain into IVC. (2A) shows the Caudate lobe (arrow head) with Caudate vein (thin arrow) and two IRHV (thick arrows). (2B) shows multiple short hepatic veins that are less than 3 mm draining directly into IVC. (2C) shows measurement of Fossa venacava, (2D) shows IRHV draining IVC at 11 and 12 O'Clock suggesting, blind insertion of forceps at 11 O'clock is NOT always safe. (2E) shows red line that is drawn between Caudate vein and IRHV. This gap is known as Vein gap. (2F) shows intraoperative view of Short hepatic vein that is being ligated. Cadaveric images are flipped (mirror) view.

Methods

This is a cross-sectional observational study carried out at College of Medical Sciences, Bharatpur, Chitwan. A total of 26 livers preserved in formalin were used for the study. These specimens were once used by the Department of Anatomy for gross anatomical teaching for students, since the establishment of the college.

Among 26 liver specimens only 20 livers could be utilized for the study. Six livers had damaged IVC or already detached IVC. The posterior wall of the inferior venacava was incised vertically at the midline, two edges were reflected towards the opposite side so as to visualize the anterior luminal wall (**Figure 1 and 2**). Each vein that drains into IVC was studied.

The distance between RHV and MHV known as Fossa venacava was measured. Two landmarks were drawn at opening of IRHV and Caudate vein. The horizontal distance between these two lines is known as Vein gap and the distance was measured using a digital Vernier caliper. Fossa venacava and Vein gap provide a safe plane for forceps insertion while tunneling the interface between the liver and IVC. To find out the safe maneuver for forceps insertion, a wire was inserted by three different maneuvers. At inferior surface of IVC, a wire was inserted just medial to IRHV, known as right course of forceps insertion. Similarly at the midline (11-12 O'clock) position wire was inserted known as the Intermediate course of forceps insertion and at the medial edge of Caudate vein, a wire was inserted known as left course of forceps insertion (**Figure 3**).

All the collected data was entered and analyzed SPSS-20. Descriptive variables were described using frequency and percentage. Continuous variables were described using mean and standard deviation

Results

The average length of retro hepatic IVC was 49.5 ± 10.6 mm (38-68 mm), and the diameter was 25.6 ± 4.4 mm (16-32 mm). Right hepatic vein had an average diameter of 8.1 ± 1.83 mm (6.2-13 mm).

Middle and Left hepatic vein had common trunk in 60% of specimen while 40% had separate insertion in IVC. The hepatic vein had extra hepatic course in 80% of specimen, while in 20% of cases hepatic vein inserted into IVC intra-parenchymally.

Inferior right hepatic vein was present in 60% of cases and were multiple IRHV in 10% of cases. Caudate vein was present in 85% of cases and were multiple in 35% of cases.

For safety of retro hepatic tunneling, distance of Fossa venacava and Vein gap three different course of forceps insertion were studied. Fossa venacava had average distance of 12.3 ±3.48 mm (4.6-18.1 mm). The distance of Vein gap was 18.9 ±7.1 mm (5.8-35 mm).

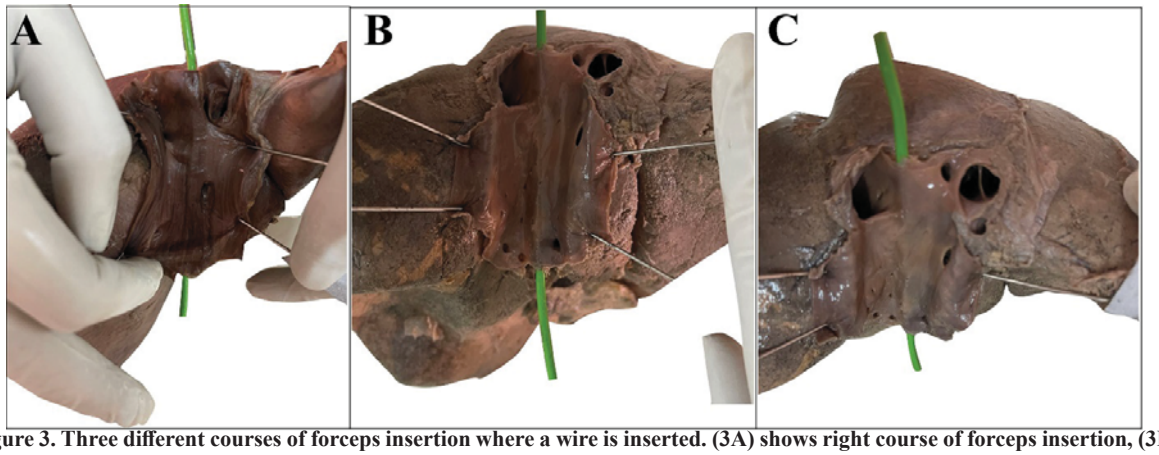

Figure 3. Three different courses of forceps insertion where a wire is inserted. (3A) shows right course of forceps insertion, (3B) shows intermediate course of forceps insertion and (3C) shows left course of forceps insertion.

Table 1. The anthropometric profile of Retro hepatic IVC, Hepatic and Interface veins

	Number	Range (mm)	Mean ±SD
Length Of Retro-hepatic IVC	20	38.00-68.00	49.5500 ±10.60027
Diameter Of Retro-Hepatic IVC	20	16.00-32.00	25.6500 ±4.40424
Diameter of Right Hepatic Vein	20	6.20-13.00	8.1175 ±1.83580
Diameter Middle Hepatic Vein	20	5.40-12.00	7.5065 ±1.61915
Diameter Of Left Hepatic Vein	20	3.28-8.90	6.2485 ±1.32908
Diameter Middle Right Hepatic Vein	2	6.00-12.10	9.0500 ±4.31335
Diameter Of Largest Inferior Right Hepatic Vein	12	4.30-7.90	6.1333 ±0.98381
Diameter Of Largest Caudate Vein	17	4.00-8.70	6.1471 ±1.27971
Fossa venacava Distance	20	4.60-18.10	12.1300 ±3.48910
Vein gap Distance	20	5.80-35.00	18.9650 ±7.15897

Right course, intermediate course and left course of forceps insertion (see methodology section) was performed where injury of major hepatic veins (IRHV or Caudate vein) occurred least frequently during intermediate course of forceps insertion. The results of these three courses of forceps insertion are provided in **Table 2**.

Discussion

Liver hanging maneuver is already an established standard technique during anterior resection. The safety of this technique depends upon safer tunneling between retro hepatic inferior venacava and liver.[1,10,11] A detail anatomical knowledge provide a guidance for safer tunneling plane.

In our study common trunk of the Middle and Left hepatic vein occurred in 60% of specimens. A similar result was found by Bundi et al. While Sahni et al showed 88% of specimens had a common trunk.[12] During left lateral sectionectomy, if there is a common trunk, the left hepatic vein should be ligated intraparenchymally without damaging the common trunk.

The distance between MHV and RHV (Fossa venacava) determines the space for forceps insertion at a suprahepatic portion of IVC while performing the hanging maneuver. The larger this distance the safer will be the dissection. In our study, the distance of Fossa venacava was 12.13 mm (4.6-18.10 mm). The study done by Hirai et al showed a distance of 10.2 ± 3.9 mm (2.6-19.7 mm).[8] Our study showed a minimum distance of more than 4 mm suggesting relative safety while inserting forceps. If the distance is very small as described by Hiral et al the forceps insertion could be hazardous. Hence we recommend enlarging the pocket using fingers or blunt instruments before introducing forceps.

The inferior right hepatic vein was present in 60% of cases and the Caudate vein was present in 85% of cases. Vein gap provide a safe plane for tunneling. We observed this gap with a mean distance of 18.9 ± 7.1 mm (5.8-35 mm). In a study conducted by Hirai et al the vein gap was 16.2 ±7.9 mm (0mm-38.6 mm) which could lead to injury of

Table 2. Caudate vein and IRHV encounter during Right, Intermediate and Left course of forceps insertion

Course of forceps Insertion	An encounter with Caudate Vein	Encounter of IRHV
Right Course of forceps insertion	3/17 (17.6%)	4/12 (33%)
Intermediate course of forceps insertion	2/17 (11.8%)	2/12 (16.7%)
The left course of forceps insertion	5/17 (29.4%)	1/12 (8.3%)

these vessels while tunneling.[8] Our study suggests at least a 5.8 mm gap and shows little risk of injury compared to the study of Hirai et al. This difference is probably because we did not study vessels less than 3mm as there will be self-hemostasis of such vessels when injured.

Three courses of forceps insertion were carried out to find out the safest course. We found the intermediate course being the safest. When there is an absent IRHV, it is always wise to undergo the right course of forceps insertion as it is the safest course found in an absent IRHV specimen. A similar result was described by Hirai et al.

The average diameter of MRHV and IRHV in our study was 9±4.32 mm and 6.1 ±0.98 mm respectively. A similar result was found in a study conducted by Sato et al.[6] During liver transplantation if such vein is of significant diameter, they need to be reconstructed to prevent congestion in the recipient's liver.

Conclusion

While tunneling during the hanging maneuver, the Fossa venacava has a very small distance, so we suggest enlarging this fossa with finger or blunt instruments. The Vein gap is also short; hence Intermediate course of forceps insertion provides the safest route for tunneling during hanging maneuver liver resection. The diameter of IRHV and MRHV is most of the time big, hence, to prevent congestion it is always advised to reconstruct such vessels whenever possible.

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