***International Journal of Biomedical and Advance Research***
ISSN: 2229-3809 (Online); 2455-0558 (Print)
Journal DOI: https://dx.doi.org/10.7439/ijbar
CODEN: IJBABN **Original Research Article**

# Porta Hepatis in Normal Liver

**Dimpy Gupta***, Priyanka N Sharma and Achleshwar Gandotra

*Department of Anatomy, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth, Vadodara, Gujarat, India*

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***Correspondence Info:**
Dr. Dimpy Gupta
Department of Anatomy,
SBKS Medical Institute & Research Centre,
Sumandeep Vidyapeeth, Vadodara, Gujarat, India

***Article History:**
**Received:** 15/02/2017
**Revised:** 18/03/2017
**Accepted:** 19/03/2017
**DOI:** https://dx.doi.org/10.7439/ijbar.v8i3.3956

## Abstract

**Background**: Hepatic surgery requires comprehensive knowledge of structures passing through porta hepatis. This fact prompted us to undertake the study of porta hepatis (PH). Our aim was to find out the dimensions, shape of porta hepatis and the numerical variations of structures passing through it.

**Material and Methods:** This study was carried out on 25 adult cadaveric formalin preserved human liver. The porta hepatis was identified and its transverse diameter, maximum anteroposterior diameter, various parts of liver contributing in its formation and total circumference were measured using Digital Sliding Vernier Caliper, thread and scale. Number of arteries, veins and ducts passing through it were observed.

**Observations and Results:** The mean transverse diameter, anteroposterior diameter and total circumference of porta hepatis was 3.80 ± 1.03 cm, 1.79 ± 0.43 cm and 13.61 ± 1.92 cm respectively. Maximum contribution to the circumference of PH was made by caudate process (18.8%) and minimum by fossa for gall bladder (13.1%). 8 specimen showed presence of2 arteries, 1 vein and 1 duct at porta hepatis. Maximum number of arteries, veins and ducts passing through PH were 5, 3 and 3 respectively in one specimen each. In most of the cases the shape of porta hepatis was triangular.

**Conclusion**: The dimensions and shape of porta hepatis; arrangement and number of structures at it is highly variable and hence its knowledge can be of great importance to hepato-billiary surgeons.

**Keywords:** Porta Hepatis, caudate process, fossa for gall bladder, Hepatic surgery.

## 1. Introduction

A liver surgery poses great challenge even for expert hands. Hepatobiliary surgery requires comprehensive knowledge of anatomy of liver and surrounding structures. Porta Hepatis (PH) is a nonperitoneal deep fissure on the inferior aspect of liver which acts as a gateway for entry or exit of neurovascular structures. These structures include hepatic artery surrounded by autonomic plexus of nerves and the portal vein entering the liver, whereas hepatic ducts and some lymphatics emerge out of the liver. Porta hepatis is bounded by left lobe, caudate lobe, caudate process, right lobe, fossa for gall bladder and quadrate lobe of liver. Due to presence of these key structures in a small area, the clinical procedures around this region are associated with many iatrogenic complications[1,2].

The variations at PH in terms of number and size of the structures passing through it, angles at which these structures enter and exit at PH are reported by many researchers around the world but Indian studies on this important anatomical area are limited[3–5]. Considering the significance of anatomical knowledge of this area, the present study was undertaken with the aim of finding out the dimensions and shape of porta hepatis with contributing structures in its formation. The study also attempted to find out numerical variations of structures passing through it.

## 2. Material and Methods

This is a Cross sectional, Observational study done on 25 adult cadaveric formalin preserved human liver irrespective of sex. Specimen showing any surface

anomalies and pathology were excluded from the study. The specimens were collected from the Department of Anatomy, SBKS Medical Institute and Research Centre, Vadodara.Ethical approval was taken from Institutional Ethical Committee prior to the commencement of the study.

On the visceral surface of each specimen of liver porta hepatis (PH) was identified. The shape of porta hepatis was observed in each specimen and recorded. Number and combination of structures passing through PH viz. hepatic artery, portal vein and hepatic duct were recorded. The transverse diameter and anteroposterior diameter of PH were measured with Digital sliding Vernier Caliper. Total circumference of PH was measured with a thin thread. The contributing dimensions of six components viz. Left lobe, caudate lobe, caudate process, right lobe, fossa for gall bladder and quadrate lobe towards the formation of porta hepatis were measured with thread and scale.

**2.1 Statistical method**

The mean, standard deviation and percentages were used to describe the distribution of data. Statistical analysis was done using SPSS version 23.

## 3. Observation and Results

The present study was done on 25 formalin preserved liver specimen of both sexes. The transverse diameter of porta hepatis ranged from 2.4 cm to 6 cm with a mean value of 3.80 ± 1.03 cm. The minimum anteroposterior diameter of the porta hepatis was 1.2 cm and maximum was 2.6cm with a mean value of 1.79 ± 0.43 cm. Total circumference of porta hepatis was measured to be a minimum of 10.2 cm and up to a maximum of 18 cm, the mean value being 13.61 ± 1.92 cm. The details of these dimensions are shown in table 1.

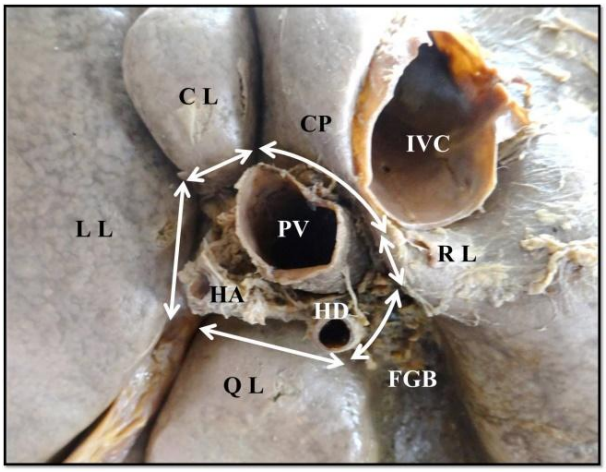
**Table 1: Dimensions of porta hepatis**

| Dimension | Minimum (cm) | Maximum (cm) | Mean ± S.D. |
|---|---|---|---|
| Transverse diameter of the Porta hepatis | 2.4 | 6 | 3.80 ± 1.03 |
| Antero-posterior diameter of Porta hepatis | 1.2 | 2.6 | 1.79 ± 0.43 |
| Total Circumference | 10.2 | 18 | 13.61 ± 1.92 |

The circumference of porta hepatis was contributed by left lobe, caudate lobe, caudate process, right lobe, fossa for gall bladder and quadrate lobe of liver (Figure 1).

Amongst the structures forming the boundaries of porta hepatis, maximum contribution was made by caudate process of liver, values of which varied from 7.8% to 31.6% with a mean value of 18.8% of the total circumference. Least contribution was made by fossa for gall bladder which ranged from 6.9% to 19.8%, mean value being 13.1%. Contribution by rest of the various components of liver is depicted in table 2.

**Figure 1: Boundaries of porta hepatis**




*LL= Left lobe, CL= Caudate lobe, CP= Caudate process, RL= Right lobe, FGB= fossa for gall bladder, QL= Qaudrate lobe of liver, IVC inferior vena cava, PV= Portal vein, HA= hepatic artery, HD= hepatic duct*

**Table 2: Contribution (%) by various components of liver towards total circumference of porta hepatis**

| No. | Components | Minimum (%) | Maximum (%) | Mean (%) |
|---|---|---|---|---|
| 1 | Left lobe of liver | 7.7 | 27.7 | 18.1 |
| 2 | Caudate lobe of liver | 9 | 27.3 | 16.6 |
| 3 | Caudate process of liver | 7.8 | 31.6 | 18.8 |
| 4 | Right lobe of liver | 7.6 | 21.9 | 16 |
| 5 | Gall bladder fossa | 6.9 | 19.8 | 13.1 |
| 6 | Quadrate lobe of liver | 10.7 | 26.2 | 17.4 |

In 36% of specimen (i.e. maximum) porta hepatis was of triangular shape, followed by 28% rectangular and 28% were of irregular shape. The least common shape was square shown by only 8% of specimen.

Structures passing through porta hepatis showed high variation in terms of their number and combination. Most common combination of structures was observed to be of 2 arteries, 1 vein and 1 duct which was seen in 32% of specimen (Figure 2), followed by combinations of 3arteries, 1 vein, 1 duct and 4 arteries, 1 vein and 1 duct in 16 % of specimen each. Table 3 shows various combinations of structures passing through porta hepatis and their frequency of occurrence.

**Figure 2: Porta hepatis with two arteries, one vein and one duct**

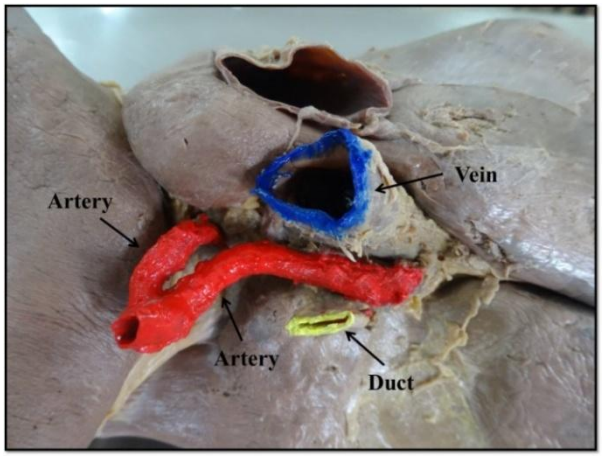


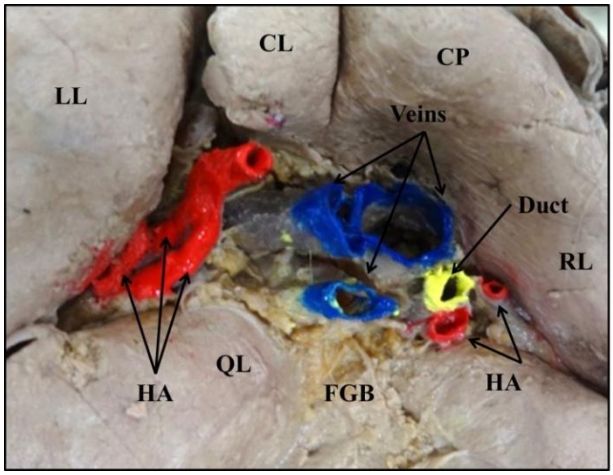

**Table 3: Various combinations of structures passing through porta hepatis and their frequency of occurrence**

| Combination | Number of specimen | % of specimen |
|---|---|---|
| 2A 1V 1D | 8 | 32 |
| 3A 1V 1D | 4 | 16 |
| 4A 1V 1D | 4 | 16 |
| 3A 1V 2D | 3 | 12 |
| 1A 1V 1D | 1 | 4 |
| 3A 1V 3D | 1 | 4 |
| 3A 2V 2D | 1 | 4 |
| 4A 2V 1D | 1 | 4 |
| 4A 2V 2D | 1 | 4 |
| 5A 3V 1D | 1 | 4 |

*A=artery, V=vein, D=duct*

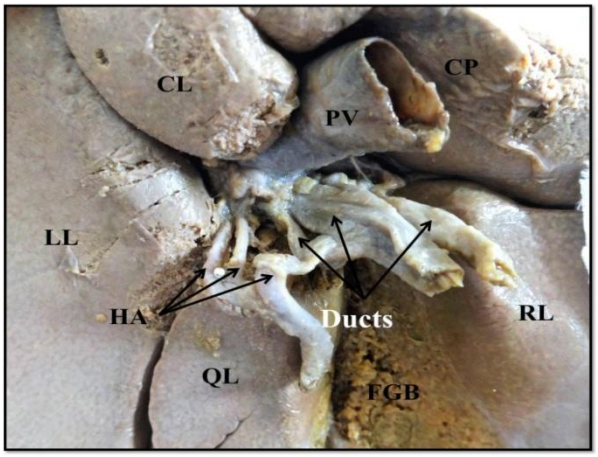
Most constant feature in PH was the location of portal vein which was the posterior most structure. There was presence of minimum one artery, one vein and one duct in each specimen whereas maximum number of arteries, veins and ducts observed in a given specimen were 5, 3 and 3 respectively found in one specimen each (Figure 3 and 4).

**Figure 3: Porta hepatis with five arteries, three veins and one duct**




*LL= Left lobe, CL= Caudate lobe, CP= Caudate process, RL= Right lobe, FGB= fossa for gall bladder, QL= Qaudrate lobe of liver, HA= hepatic artery*

**Figure 4: Porta hepatis with three arteries, one vein and three ducts**




*LL= Left lobe, CL= Caudate lobe, CP= Caudate process, RL= Right lobe, FGB= fossa for gall bladder, QL= Qaudrate lobe of liver, HA= hepatic artery, PV= Portal vein*

All the arteries observed were branches of hepatic artery which branched before entering into porta hepatis and all the ducts were branches of/or hepatic ducts. No cystic duct was observed emerging from the porta hepatis. Table 4 shows the number of ducts, veins and arteries passing through the porta hepatis and the frequency of their occurrence.

**Table 4: Number of structures passing through porta hepatis and frequency of their occurrence**

| Number of structures | Number of specimen | % of specimen |
|---|---|---|
| 1 artery | 1 | 4 |
| 2 arteries | 8 | 32 |
| 3 arteries | 9 | 36 |
| 4 arteries | 6 | 24 |
| 5 arteries | 1 | 4 |
| 1 vein | 21 | 84 |
| 2 veins | 3 | 12 |
| 3 veins | 1 | 4 |
| 1 duct | 19 | 76 |
| 2 ducts | 5 | 20 |
| 3 ducts | 1 | 4 |

## 4. Discussion

Liver, most maligned organ in recent times by virtue of unhealthy lifestyle leading to fatty liver, cirrhosis, hepatic failure. Prevalence of gall stones and various liver pathologies caused by alcohol use, Hepatitis B and C infection is showing rising trend in India and throughout the world[6,7]. These pathologies necessitate various diagnostic and therapeutic clinical procedures to be performed on this area which are not without complications. Common complications of surgeries around liver may be vascular or nonvascular like biliary peritonitis or biliary stricture following bile duct injury, ischemic cholecystitis due to gall bladder injury, vascular injuries like pseudo aneurysms,

hematoma, arterial dissections or transections etc.[1,2,8]. Complications can also occur following minimally invasive procedures like percutaneous drainage catheter placement, balloon dilatation, stenting, and coil embolization[1,2,9. Considering the size and nature of these complications it is imperative that the clinician working on this area must be well versed with the detail of anatomical knowledge and its variations. Literature on anatomical knowledge on this area has not proved to be adequate to reduce the incidence of iatrogenic complications.

Present study was conducted on twenty five formalin preserved liver specimen of both sexes to evaluate the gross anatomy of this region. The study measured anteroposterior diameter, transverse diameter and total circumference of porta hepatis. The shape of porta and various structures entering and exiting through PH were also recorded to study the pattern of variations. The most constant feature was the location of portal vein situated posterior to the artery and the duct which confirms with other researchers[10,11]. Majority of the previous similar studies have focused on branching pattern of vessels or biliary structure and variations in it[12–15]. Scanty information is available regarding the dimensions of PH, contribution of various parts of liver towards the formation of porta hepatis and overall shape of porta. The authors came across study conducted by Sapna *et al*[10] the findings of which were of similar pattern. Table 5 shows the details of comparison.

**Table 5: Comparison of various findings with other studies**

| Findings | Present study | Sapna *et al*[10] | Chaib[13] |
|---|---|---|---|
| Transverse diameter of the Porta hepatis | 3.80 cm ± 1.03 (2.4cm to 6cm) | 4.83 cm (2.5cm to 8cm) | -- |
| Antero-posterior diameter of Porta hepatis | 1.79 cm ± 0.43 (1.2cm to 2.6cm) | 2.43 cm (1.25cm to 3cm) | -- |
| Most common combination | 2A 1V 1D (32%) | 2A 1V 1D (25.4%) | Bifurcation of portal vein (83.3%) |
| Max no. of arteries | 5 | 4 | -- |
| Max no. of veins | 3 | 3 | 3 |
| Max no. of ducts | 3 | 3 | -- |

*A=artery, V=vein, D=duct*

The finding of this study explains the fact that there are wide variations in dimensions of Porta Hepatis and structures present at it. It can also be deduced from the results that contribution of different parts of liver towards formation of porta does not follow specific pattern. The nature and quantity of variations reported by this study highlights that the clinicians working on this area shall be extremely cautious to avoid iatrogenic complications. The fact that even with limited sample size we have found wide ranging variations, the author recommends the need for doing similar studies with larger sample size.

## 5. Conclusion

The findings of this study suggest that dimensions and shape of porta hepatis; arrangement and number of structures at it is highly variable. Its knowledge can be of great importance to hepatobilliary surgeons.

## Acknowledgements

We are extremely grateful to Dr. Manoj Kulkarni, Associate Professor, Dept. of Anatomy, SBKSMI&RC, Vadodara, for his remarkable help in statistics. We are most thankful to the incharge of dissection hall for providing us all necessary help and assistance.

*Funding:* None

## References

[1] Vachhani PG, Copelan A, Remer EM, Kapoor B. Iatrogenic Hepatopancreaticobiliary Injuries: A Review. *SeminInterv Radiol*. 2015 Jun; 32(2):182–94.

[2] Grat M, Grzegorczyk K, Lewandowski Z, Sujecki D, Szwedowski D, Boltuc A, *et al*. Intraoperative injuries during liver resection: analysis of 1,005 procedures. *Hepatol Int.* 2011 Jun 14; 6(2):498–504.

[3] Covey AM, Brody LA, Getrajdman GI, Sofocleous CT, Brown KT. Incidence, patterns, and clinical relevance of variant portal vein anatomy. *AJR Am J Roentgenol.* 2004 Oct; 183(4):1055–64.

[4] Nigam GL, Lalwani R, Agrawal D, Chauhan K. Evaluation Of Branching Pattern Of Hepatic Artery. *Internet J Gastroenterol [Internet]*. 2012 Jan 24 [cited 2017 Feb 13]; 11(1). Available from: http://ispub.com/IJGE/11/1/13847

[5] Thungsuppawattanakit P, Arjhansiri K. Anatomic variants of intrahepatic bile ducts in Thais. *Asian Biomed.* 2012; 6(1):51–7.

[6] Pitchumoni CS. Increasing Prevalence of Gallstones; Diagnostic and Therapeutic Options. *Med Update*. 2010; 20:486–90.

[7] Mokdad AA, Lopez AD, Shahraz S, Lozano R, Mokdad AH, Stanaway J, *et al*. Liver cirrhosis mortality in 187 countries between 1980 and 2010: a systematic analysis. *BMC Med*. 2014; 12:145.

[8] Lyu S-Y, Kuang-Tse Pan, Sung-Yu Chu, Ming-Yi Hsu, Chien-Ming Chen, Chien-Fu Hung, *et al*. Common and rare variants of the biliary tree: Magnetic resonance cholangiographic findings and clinical implications. *J Radiol Sci*. 2012; 37(2):59–67.

[9] Davidoff AM, Pappas TN, Murray EA, Hilleren DJ, Johnson RD, Baker ME, *et al*. Mechanisms of major biliary injury during laparoscopic cholecystectomy. *Ann Surg.* 1992 Mar; 215(3):196–202.

[10] Sapna M, Shetty SD, Nayak S. A Study on the Number and Arrangement of the Structures Passing Through the Porta Hepatis in South Indian Population. *Int J Morphol.* 2015; 33(1):164–168.

[11] Tirumani SH, Prasad Shanbhogue AK, Vikram R, Prasad SR, Menias CO. Imaging of the Porta Hepatis: Spectrum of Disease. *Radio Graphics*. 2014 Jan 1; 34(1):73–92.

[12] Turner MA, Fulcher AS. The Cystic Duct: Normal Anatomy and Disease Processes. *Radio Graphics*. 2001; 21(1):3–22.

[13] Chaib E. Absence of bifurcation of the portal vein. *Surg Radiol Anat SRA.* 2009 Jun; 31(5):389–92.

[14] Kamath. B. K. A study of variant hepatic arterial anatomy and its relevance in current surgical practice. *Int J Anat Res.* 2015 Mar 31; 3(1):947–53.

[15] Raut RS, Bahetee BH. Study of Anatomical Dimensions of Portal Vein. *Sch J Appl Med Sci.* 2015; 3(3E):1343–5.