

# Morphometry of the Portal Vein: Ultrasound Anatomy about 1000 Cases

Abdoulaye Kanté<sup>1,2</sup>, Abdoulaye Koné<sup>3</sup>, Daouda Camara<sup>4</sup>, Bréhima Bengaly<sup>1</sup>, Bréhima Coulibaly<sup>1</sup>, Drissa Traoré<sup>1</sup>, Babou Ba<sup>2</sup>, Mariam Daou<sup>3</sup>, Nouhoum Ongoïba<sup>1,2\*</sup>

<sup>1</sup>Service of Surgery B. CHU Point G, Bamako, Mali

<sup>2</sup>Laboratory of Anatomy of the Faculty of Medicine and Odontostomatology, Bamako, Mali

<sup>3</sup>Imaging Department CHU Point G, Bamako, Mali

<sup>4</sup>Service of Gynecology and Obstetrics of the CHU, Kati, Mali

Email: kanteim@yahoo.fr, \*ongoibano@yahoo.fr

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## Abstract

**Aim:** The aim of this study is to determine from a series of 1000 cases the usual dimensions of the portal vein according to the medical ultrasound.

**Methodology:** We realized a transverse study over 2 years (from January 2015 to December 2017). It concerned an ultrasound exploration of the portal vein. The studied population was healthy voluntary subjects visible without history of abdominal trauma and abdominal operating scar. **Results:** The average age was 39 years  $\pm$  12.16 with extremes of 19 years and 70 years. The decade of 21 - 29 years represented 46.2%. The transverse diameter of the portal vein in its origin varied between 8 and 10 mm in 57.9% of the cases. The average was 9.05  $\pm$  2.82 mm with extremes of 5 and 16 mm. The transverse diameter of the portal vein in its ending varied between 8 and 10 mm in 56.9%. In 29.8% of the cases, the length of the portal vein was between 61 and 70 mm and in 8.8% between 81 and 100 mm. The average length was 58  $\pm$  22.3 mm. Before its penetration in the liver, the portal vein divided into 2 branches in 967 cases (96.7%) and in 3 branches in 33 cases (3.3%). **Conclusion:** This original study shows the normal dimensions of the portal vein to Malian.

## Keywords

Anatomy, Portal Vein, Ultrasound, Bamako-Mali

## 1. Introduction

The portal vein (PV) or the portal trunk carries blood from the diaphragmatic part of the digestive tract, the spleen and the pancreas. Its origin is situated behind the isthmus of the pancreas by the confluence of the superior mesenteric

vein and of the splenic trunk (formed by splenic vein and inferior mesenteric vein) [1]. The cystic and the left and right gastric veins are other tributaries of the portal vein [2]. In its route the PV is oblique at the top and forward. It ends by giving at the level of the hepatic hilum, right and left branches which move away by limiting an open very obtuse angle at the top. Branches win the corresponding extremity of the cross-functional furrow then sink into the liver. The PV establishes the later plan of the hepatic pedicle [1]. Therefore, in the surgery of the liver and the biliary ways, the PV constitutes an important anatomical mark, its dimensions are variously estimated by the authors [3] [4]. The average length of the trunk wears according to Rouvière is 100 mm and its diameter 15 mm. Castaing in 1999 found that the length of the PV varies between 80 and 100 and its diameter between 15 and 20 mm [2]. But the conditions and the exact siege of the dimensions are not specified by the authors except for Ongoïba [5].

Outside the ultrasound study realized by Ongoïba in 2003, we did not find other anatomo-ultrasound studies on the PV. To mitigate this deficit of search on the morphometry of the portal vein, we led this study with as objective to determine from a series of 1000 cases the usual dimensions of the PV according to the ultrasound.

## 2. Materials and Methods

We realized a transverse study over 2 years (between from January 2015 to December 2017). It concerned an ultrasound exploration of the PV. The studied population was healthy voluntary subjects visible without history of abdominal trauma and abdominal operating scar. The carrying subjects of the tracks of abdominal trauma or of abdominal operating scar were not included.

Three different sonographers made at the same time this examination by using the same protocol and type Aloka's same device SSD-1700 provided with a convex probe of 3.5 MHz. During the ultrasound, we spotted the PV and measured its diameters in the origin, in the ending and its length. The number of its terminal branches was counted. Diameters were measured on a longitudinal incidence. The results were expressed in millimeter.

The data were seized and analyzed on the software Ear information (version 6). The tests of  $X^2$  and Student's were used to compare our results with those of the other authors. The threshold of meaning was fixed to 0.05.

The test meadow which allowed us to standardize the methodology concerned 10 subjects. Then the study concerned 1000 subjects.

## 3. Results

The average age subject was  $39 \pm 12.16$  years with extremes of 19 and 70 years. The age bracket of 21 - 29 years represented 46.2%. It was about 500 women (50%) and of 500 men (50%). The sex ratio was 1.0.

700 person (70%) lived in Bamako whereas 300 (30%) came from 8 regions of Mali. The results of the test meadow which concerned 10 subjects are in **Table**

1. The results of the second part of the study are in **Tables 2-4** and **Figures 1-3**.

### 3.1. Highlighting of the Portal Vein and Its Branches

The frequency of the highlighting of the PV was represented in **Table 2**.

In 98% of the cases the transverse diameter of the portal vein was highlighted in its origin, while in its ending, the transverse diameter was highlighted in 98.5% of the cases, and at least 2 branches were seen in 100%.

### 3.2. Dimensions of the Portal Vein

#### 3.2.1. Transverse Diameter of the Portal Vein in Its Origin

The transverse diameter of the PV in its origin varied between 8 and 10 mm in 57.9% of the cases. The average was  $9.05 \pm 2.82$  mm with extremes of 5 and 16 mm (**Figure 1**).

**Figure 2** shows the origin and trajectory of the portal vein.

#### 3.2.2. Transverse Diameter of the Portal Vein in Its Ending

The transverse diameter of the PV in its ending varied between 8 and 10 mm in 56.9%. The average was  $9.16 \pm 2.58$  mm with extremes of 6 and 16 mm (**Figure 3**).

**Figure 4** shows the measurement of the transverse diameter of the vein leading to its termination.

#### 3.2.3. Length of the Portal Vein

In 29.8% of the cases, the length of the portal vein was between 61 and 70 mm and in 8.8% between 81 and 100 mm. The average was  $58 \pm 22.3$  mm (**Figure 5**).

#### 3.2.4. Number of Terminal Branches of the Portal Vein

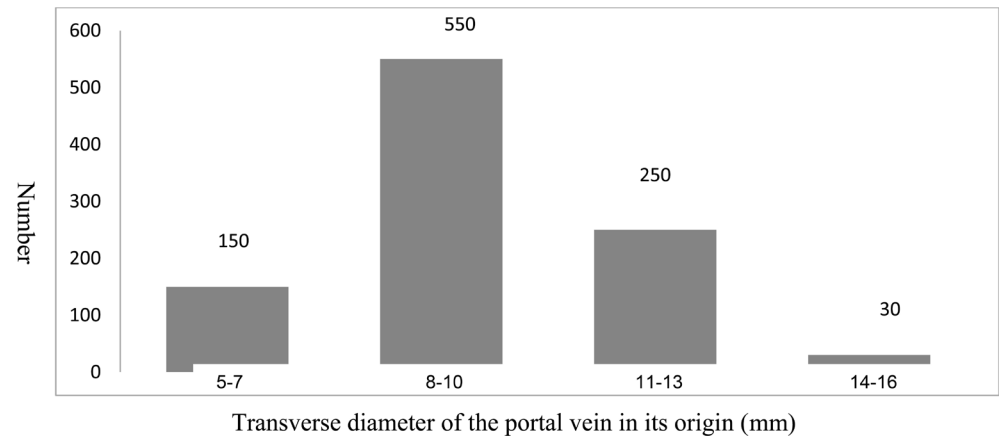
Before its penetration in the liver, the portal vein divided into 2 branches in 967

**Table 1.** Average dimensions of 10 portal veins according to three sonographers.

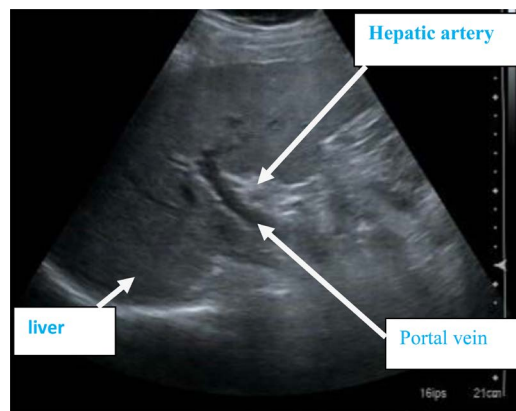
Examiners Variables (mm)	Sonographer n°1	Sonographer n°2	Sonographer n°3	F	P
Transverse diameter of the PV in its origin	9.40 ± 1.68	9.65 ± 1.67	9.80 ± 1.66	0.15	0.8
Transverse diameter of the PV in its ending	9.62 ± 7.79	9.15 ± 1.70	9 ± 1.61	0.36	0.9
Length of the PV	61.22 ± 15.48	61.30 ± 14	61.33 ± 13.22	0	0.9
Number of terminal branches of the PV	2	2	2		

**Table 2.** Frequency of the highlighting of the various dimensions of the PV.

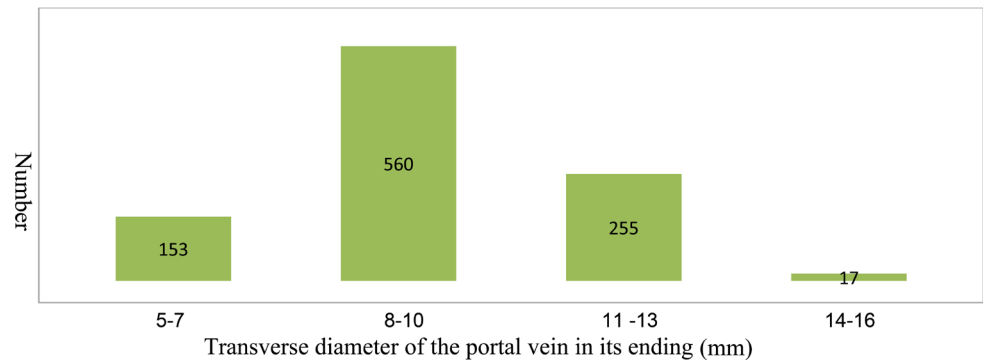
Highlighting of the dimensions of the PV	Not seen	Frequency %	Seen	Frequency %	Total
Transverse diameter of the PV in its origin	20	2	980	98	1000
Transverse diameter of the PV in its ending	15	1.5	985	98.5	1000
Length of the PV	20	2	980	98	1000
Number of terminal branches of the PV	0	0	1000	100	1000



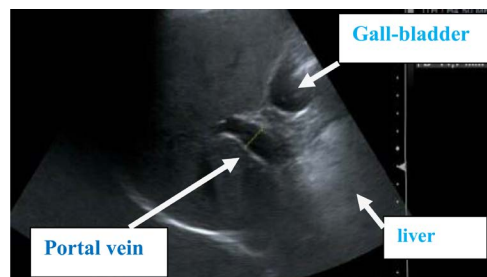
**Figure 1.** Subjects according to the transverse diameter of the portal vein in its origin.



**Figure 2.** Ultrasound cut in mode through the hepatic hilum showing the vein measure having its origin.



**Figure 3.** Subjects according to the transverse diameter of the portal vein in its ending.



**Figure 4.** Ultrasonographic cut through the hepatic hilum showing the vein measure ending.

cases (96.7%) and in 3 branches in 33 cases (3.3%) (Figure 6).

### 3.2.5. Dimensions of the Portal Vein According to the Age

Table 3 shows the dimensions of the portal vein before and after 20 years. To the subjects from 11 to 20 years, the average of the transverse diameter of the portal vein in its origin was  $8.9 \pm 2$  mm. This diameter was  $9.6 \pm 1.9$  mm to the subjects of more than 20 years ( $p = 0.298$ ). The difference was not significant. To the subjects from 11 to 20 years, the transverse diameter of the PV in its ending was  $9.6 \pm 2$  mm ( $p = 0.567$ ). The difference was not significant.

### 3.2.6. Dimensions of the Portal Vein According to the Sex

Table 4 shows the dimensions of the PV according to the sex. To the male subjects, the average of the transverse diameter of the PV in its origin was  $9.7 \pm 1.9$  mm. This average was  $9.3 \pm 2$  mm to the female subjects ( $p = 0.411$ ).

To the male subjects, the average transverse diameter of the portal vein in its ending was  $9.4 \pm 2.2$  mm. This average to the female subjects was  $9.6 \pm 1.7$

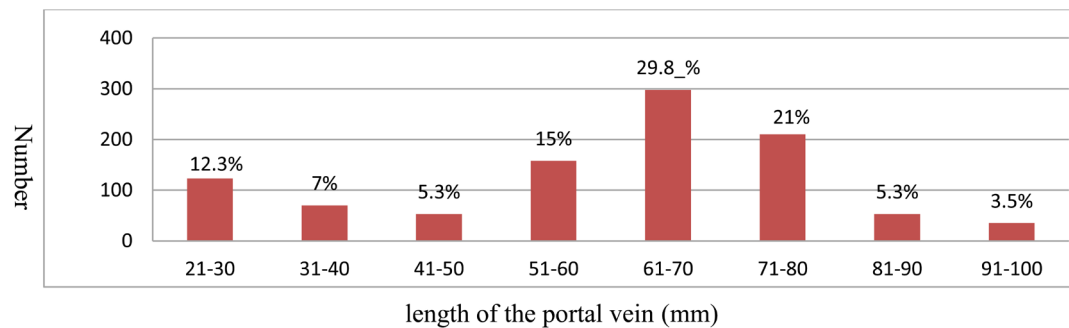


Figure 5. Subjects according to the length of the portal vein.

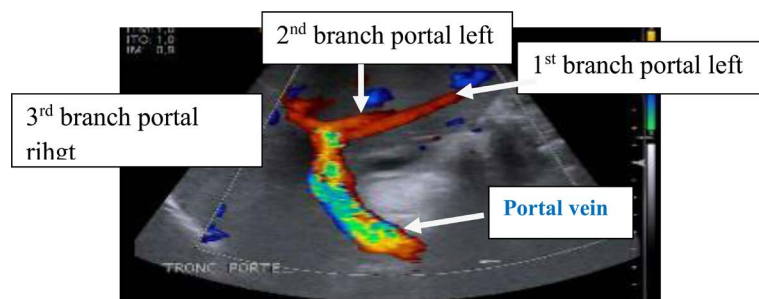


Figure 6. Color Doppler ultrasound cut through hepatic hilus showing division of vein in three branches.

Table 3. Average dimensions compared by the PV between the subjects of less than 20 years and those of more than 20 years.

Age in year	<20 ans	>20 ans	P
Dimensions PV (mm)	n = 134	n = 866	
Average transverse diameter of the PV in its origin	$8.8 \pm 2$	$9.6 \pm 2$	0.298
Average transverse diameter of the PV in its ending	$9.1 \pm 1.5$	$9.3 \pm 2$	0.567
Length averages of the PV	$48.8 \pm 17.6$	$46.31 \pm 17.3$	0.033

**Table 4.** Average dimensions compared by the portal vein between the male and female subjects.

Sex Dimensions PV (mm)	Male n= 500	Female n= 500	P
Diameter of the PV in its origin	9.7 ± 1.9	9.3 ± 2	0.411
diameter of the PV in its ending	9.4 ± 2.2	9.6 ± 1.7	0.730
Length of the PV	65.2 ± 16.4	57.7 ± 17.8	0.001

mm ( $p = 0.730$ ).

The average length of the portal vein to the male subjects was  $65.2 \pm 16.4$  mm. To the female subjects, this average was  $57.7 \pm 17.8$  mm. The difference was statistically significant ( $p = 0.001$ ).

#### 4. Discussion

We measured in the ultrasound the transverse diameter of the PV in its origin and in its ending and its length.

We did not find significant difference between certain dimensions (transverse diameters, original and terminals) of the vein of the subjects of less than 20 years versus the subjects of more than 20 years. We did not either find statistically significant difference between certain dimensions (transverse diameters, original and terminals) of the PV of the male subjects versus the female subjects.

In the classic anatomical descriptions the number of subjects is very limited (1 - 10) and in certain cases the studied number of subjects is not specified [2] [6] where from the difficulties of comparison between our results and those of the anatomical literature.

The length of the PV had been measured by various authors during anatomical dissections (Table 5). We found a single ultrasound study concerning the length of the portal vein.

Our results are little different from those of Delorme and Seymour [6]. The average reported by Rouvière is superior to ours. It could give some explanation by the fact that the conditions of measure are different: measure made by dissection and ultrasound measure.

The diameter of the PV is a more important parameter because it is one of important criteria to make the diagnosis of high pressure in the portal system.

According to certain authors, the normal diameter of the PV measured in hepatic hilum, should not exceed 12 in 15 mm [7]. The same authors considered that the caliber of the PV is decreasing in the sense of the flow portal [7]. In our sample, we found that the transverse diameters of the PV in its origin and in the ending were respectively  $9.05 \pm 2.82$  mm and  $9.16 \pm 2.58$  mm.

The decreasing caliber of the PV in the sense of the flow portal evoked by Weinreb [7] was not observed in our study.

In the constitution of the PV, intervene two big venous trunks: the spleno mesenteric trunk and the superior mesenteric vein. The place of convergence of

**Table 5.** Averages length of the PV according to the authors.

Authors	Type of study	Length of the PV
Rouvière	Dissection	10
Delorme	Dissection	10
Seymour	Dissection	10
Ongoïba	Echography	10
Our study	Echography	1000

these two veins, that is the origin of the portal vein, can be dilated.

In the modal arrangement, the portal vein divides in two branches which penetrate into the liver. In our study this arrangement was observed in 96.7% of the cases. In 3.3% of the cases, the portal vein had three branches. We can consider this phenomenon an anatomical variation or a premature division of the portal vein.

## 5. Conclusion

This original study shows the normal dimensions of the portal vein in Malian. These measures can serve in the diagnosis of the portal hypertension.

## Authorization of the Ethics Committee

The Ethics Committee of the Faculty of Medicine and Odontostomatologie gave us its agreement for the realization of this study.

The subjects on which were realized various measures gave their consent for the publication.

## Conflicts of Interest

We, authors of this article declare that there is no conflict of interests.

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