ORIGINAL COMMUNICATION

VARIANT ANATOMY OF THE RIGHT PORTAL VEIN IN A BLACK KENYAN POPULATION

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ABSTRACT

Surface mapping of the liver before invasive procedures depends on a proper understanding of its segmental vasculature. The right portal vein ramification and lengths show marked variations and these mostly involve its right posterior sectoral branch. Their incidence is variable among populations and altogether undocumented among Africans. One hundred livers obtained during autopsies and dissections at the Department of Human anatomy, University of Nairobi, were used in this study. Gross dissection was done to reveal and determine the branching pattern of the right portal vein and the origin of the right posterior sector branch. The lengths of the right portal vein were also measured and recorded. When present, the right portal vein terminated by bifurcation in 61% of the cases, trifurcated in 20.8% and quadrifircated in 18.2%. Its length was between 0.5cm and 4cm. The right posterior sector vein was given off the main portal vein in 34 cases, the common left portal vein trunk in 15 cases, and the right portal vein in 42 cases. In 9 cases, it was not observed at the porta hepatis. We report significant different incidences of the variant anatomy of the right portal vein compared to those found in previous studies and this should be borne in mind when doing surgical interventions.

Key words: Segmentectomy, transjugular, Surface mapping, Bifurcation

INTRODUCTION

The right portal vein (RPV) is involved in majority of variations involving the portal venous system (Arora et al., 2003). Such variations increase the risks of vascular injury during surgical procedures such as hepatectomies; split or living donor transplantation and other complex interventional procedures such as portal vein embolization and the placement of transjugular intra hepatic portosystemic shunts [TIPS] (Maddoff et al., 2002; Lee et al., 2008).

Conventionally, the RPV is a branch of the portal vein (PV) and terminates in bifurcation to give the right posterior portal vein (rpPV) and the right anterior portal vein [raPV] (Williams et al., 2004). Occasionally, the PV terminates by bifurcating into a common left portal vein trunk and the raPV (Covey et al., 2004). In such cases, the RPV is missing and consequently the rpPV originates from the common left portal vein trunk. In other instances, the raPV, rpPV and the left portal vein (LPV) all originate directly from the PV (Atasoy and Oruzek, 2006; Koc et al., 2007). Such branching patterns determine the orientation of the branches given which is vital for the surface mapping of the liver during hepatic segmentectomy (Arora et al., 2003).

Although the RPV terminates by bifurcating into the raPV and the rpPV (Ortale et al., 2000), it may trifurcate or quadrifurcate. When it quadrifurcates, its usual branches (raPV and rpPV) are replaced by their

subsequent branches: posterosuperior, posteroinferior, anterosuperior and anteroinferior portal veins (Ortale et al., 2000; Akgul et al., 2002; Atasoy and Oruzek, 2007). All these differences in the RPV termination are known to affect its length (Arora et al., 2003) with a length range previously reported to be between 0.5 and 2.6cm (Gupta et al., 1977; Ralph et al., 1989; Mishra et al., 1998; Arora et al., 2003). The incidences of these variations among populations differ and data depicting an African population is scarce. Thus, thorough understanding of the hepatic vasculature is of paramount importance. This study therefore aimed at describing the variant anatomy of the RPV.

MATERIALS AND METHODS

One hundred livers obtained from adult black Kenyans during dissection sessions at the Department of Human Anatomy, University of Nairobi Kenya, were used in this study. Ethical approval for the study was granted by Kenyatta National Hospital-University of Nairobi Ethics and Research Committee. Cirrhotic livers and those harvested from individuals with abdominal injuries involving the liver and the portal system or history of previous hepatic and pancreatic surgery were excluded from the study.

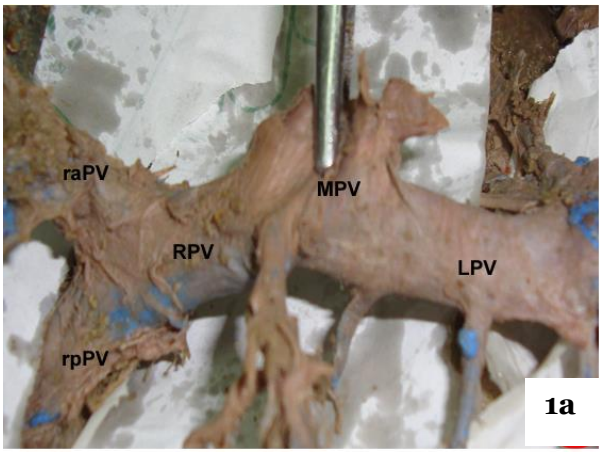
Once the abdomen was opened and its viscera exposed, the hepatogastric and hepatoduodenal ligaments were cut to separate the liver from the stomach and the duodenum. The stomach was then retracted laterally. Once identified, the PV was followed superiorly along the right free border of the lesser omentum up to the *porta hepatis*. The liver was subsequently detached from the anterior abdominal wall by incising the falciform ligament and from the diaphragm by incising the triangular and the falciform ligaments. The PV was cut close to its formation and the whole liver lifted from the abdominal cavity with the vein attached.

The porta hepatis was dissected clean and the PV termination exposed. Its termination pattern was then observed and noted. The RPV was then followed in its course up to its termination by a careful dissection of both the hepatic parenchyma and the sheath surrounding it. Its pattern of termination was noted. The termination pattern was bifurcation if it gave two branches; trifurcation if it gave three and quadrifurcation if it gave out four branches. The RPV length was directly measured using a ruler (accuracy of 0.1cm) and recorded. Data was analyzed using SPSS version 18 and results presented using graphs and charts.

RESULTS

The right portal vein: The RPV was present in 51 cases for which the PV had terminated in conventional bifurcation (figure 1). Of the remaining 49 cases, the PV trifurcated in 34 cases giving off the LPV, raPV and the rpPV. Thus, the RPV was replaced by its branches (Figure 2). In 15 cases the raPV was a direct branch of the PV while the rpPV was given off by the common LPV trunk. When present, the RPV terminated in three patterns: it bifurcated into the right posterior and right anterior portal veins; trifurcated into the right posterior, the right anterior superior and right anterior inferior portal veins; and quadrifurcated into the right anterior superior, right anterior inferior, right posterior superior and right posterior inferior branches (Figure 3; Table

1).The average length of the right portal vein ranged from 0.5 – 4.0 cm (mean 2.12 ± 0.818). Out of the 51 right portal veins measured, majority were between 1.6 and 2.0 cm long [33.3%] (Figure 4).



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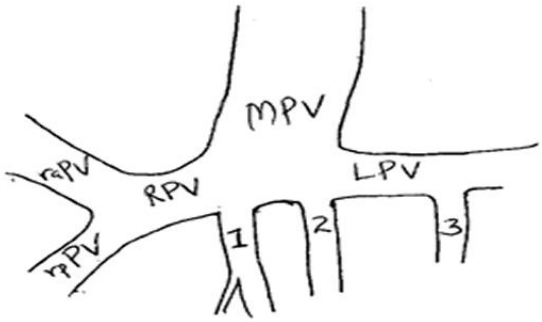

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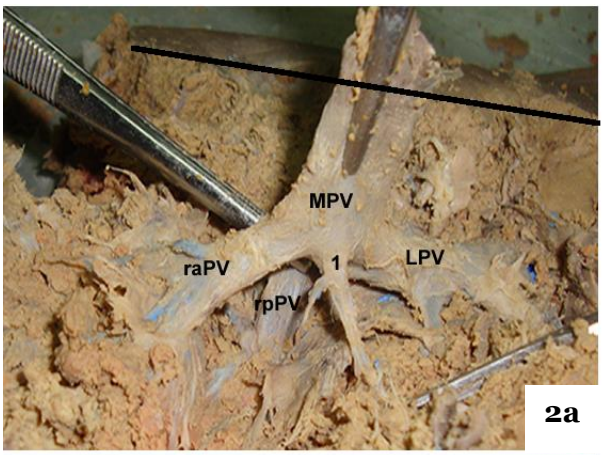
Figure 1: The conventional termination pattern of the RPV into the raPV and rpPV. (MPV- main trunk of the portal vein; RPV- right portal vein; LPV- left portal vein; raPV- right Anterior portal vein; rpPV- right posterior portal vein; 1, 2 & 3- branches to the caudate lobe)



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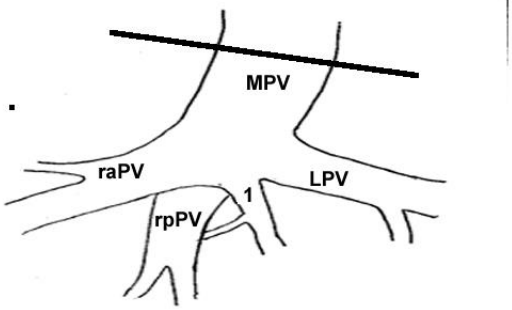

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Figure 2: Trifurcation of the PV giving the left, right anterior and right posterior portal veins. MPV is the main trunk of the portal vein, raPV is right anterior portal vein, and rpPV is right posterior portal vein. 1 is a branch to the caudate lobe.

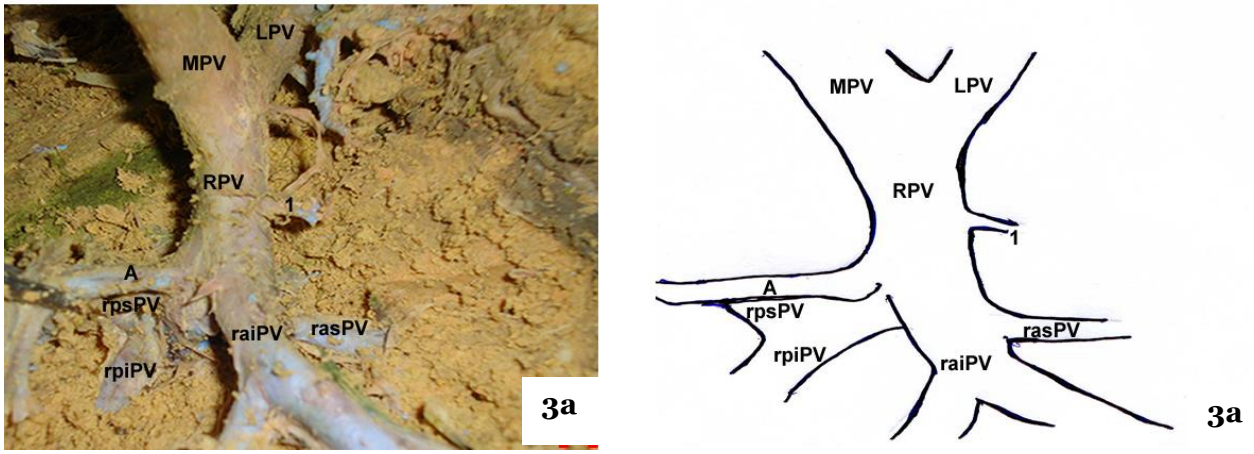
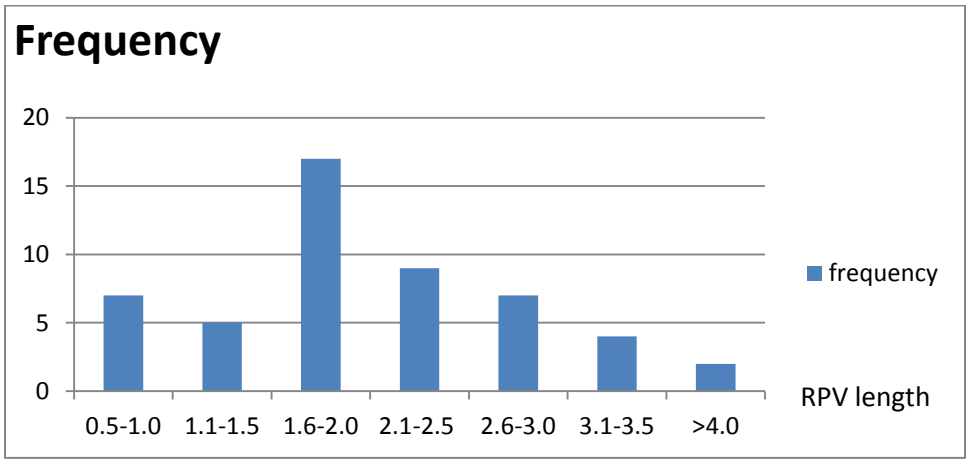


Figure 3: A trifurcation of the RPV into rasPV, raiPV and rpPV. The rpPV gave an accessory branch, A, to segment 7 before branching into the rpiPV and rpsPV branches.The caudate lobe received a branch (1) from the RPV. (MPV- main trunk of the portal vein; RPV- right portal vein; LPV- left portal vein; raPV- right anterior portal vein; rpPV- right posterior portal vein; rpsPV – right posterior superior portal vein; rpiPV – right posterior inferior portal vein; rasPV – right anterior superior portal vein; raiPV – right anterior inferior portal vein; 1- branch to the caudate lobe)

Table 1: Termination Pattern of the Right Portal Vein

Branching pattern	Frequency	Percentage
Bifurcation	31	61
Trifurcation	11	20.8
Quadrifacation	9	18.2
Total	51	100

Figure 4: Frequencies of the lengths of the right portal vein



Origin of the Right Posterior Portal Vein: Since the origin of the right posterior portal vein is known to vary, the prevalence of its origin from the various parent vessels was

determined. The right posterior portal vein was a direct branch of the main portal vein in 34 cases, a branch of the common LPV trunk in 15 cases, and a branch of the right portal vein in 42 cases. In 9 cases, the right portal vein terminated by giving four

branches. In these cases, the right anterior and right posterior portal veins were replaced by their respective branches and thus the right posterior portal vein was missing.

DISCUSSION

Hepatectomy, liver transplantation, portal vein embolization and placement of transjugular intrahepatic portosystemic shunts are interventional procedures that may be done on the liver (Maddoff et. al 2004). For their success, a thorough understanding of hepatic vasculature and biliary system is essential. Variations in the portal venous trunk have been reported in literature but with varying prevalence (Munguti et al, 2013). They include variations in level, pattern of termination and lengths of the intrahepatic and extrahepatic portions of the PV, origin of the right posterior portal vein; and the length and termination pattern of both the right and left portal veins (Atasoy and Oruzek, 2007).

Surface mapping of the liver before invasive procedures depends on a proper understanding of the approximate lengths of its segmental vasculature (Maddoff et al., 2004). The length and orientation of the right portal vein is therefore important during right hepatectomy and/or transplantation. In the current study, the right portal vein was a direct branch of the main portal vein in 51% of the cases. This was below the range of previously reported incidences of between 65.5% and 88% (Gupta et al., 1977; Akgul et al., 2002; Atasoy and Oruzek, 2007; Koc et al., 2007). This reveals the possibility that the portal venous system is more variable in the African population compared to Caucasian populations. The current study however supports previous evidence that there seems to be interethnic differences in the termination pattern of the portal venous system.

The length of the RPV in the present study ranged between 0.5cm and 4.0cm. This is in agreement with previous findings that the lowest length of the RPV is 0.5cm (Gupta et al., 1977; Ralph et al., 1989). Moreover, majority of the RPV were within the previously documented length of up to 2.6cm. However, the findings of the current study showed an upper limit higher than the previously reported one with 25.4% of the studied right portal veins having longer lengths than the hitherto recorded maximum length of 2.6cm (Mishra et al., 1998) (Table 2). Even though this may reflect a larger liver width among the Africans, future studies may require the correlation of the RPV length with the liver width to ascertain this finding.

The conventional branching of the RPV occurred in 61% of the livers with bifurcation of the PV compared to 96.1% cases reported by Koc et al., 2007. On their part, Atasoy and Oruzoy, 2006 reported an incidence of 83.2% while Wu et al., 2007 reported 70%. Three other studies reported a 100% incidence (Gupta et al., 1977; Shin et al., 1997; Ortale et al., 2000). Notably, majority of these previous studies were done using imaging techniques and in different study settings. These notwithstanding, a true inter-population difference cannot be overlooked. Therefore, this necessitates the need for imaging studies of the liver among black Kenyans prior to invasive surgical procedures in order to minimize intraoperative liver injuries.

Table 2 Lengths of the Right Portal Vein

Author	Year	Length (cm)
Gupta et al.,	1977	0.5 – 2.0
Ralph	1989	0.5 – 1.0
Mishra et al.,	1998	1.0 – 2.6
Arora et al.,	2003	1.3 – 2.3
Munguti et al.,	Present	0.5 – 4.0

Trifurcation of the right portal vein in the current study occurred in 20.8% cases similar to findings by Wu et al., 2007 at 20% and 12.2% as reported by Atasoy and Oruzoy, 2006. Comparing the three studies further, quadrifurcation of the right portal vein occurred in 18.2% in the current study, 2.2 % in Wu's study and in 0.8% in Atasoy's study. The present study reveals that higher incidences of right portal vein quadrifurcation do occur. Even though these three studies cannot be used to make conclusive remarks on the prevalence of these variations, they seem to point out that their occurrence is highly variable. This therefore needs to be borne in mind during segmental hepatectomy and portal vein embolization involving the right hemiliver.

The right posterior portal vein has been known to be the most variant branch of the portal vein with regard to its origin (Ortale et al., 2000). While conventional origin occurred in 63% in the current study, studies using computed tomography seem to have a high prevalence of this pattern of origin: 83.2% with n=200 (Atasoy et al., 2006) and in 86.2% with n=655 (Akgul et al., 2002). Whether this can be attributed to the large study samples and methodology of the previous studies or has any relation to population variation needs further imaging studies among the African population to ascertain it.

The right posterior vein portal vein is a direct branch of the PV in 8.9% to 35.5% (Lee et al., 2003; Atasoy et al., 2006; Koc et al., 2007). This is reflected in the findings of the present study at 23%. Quadrifurcation of the RPV occurs in less than 2% of the cases (Atasoy et al., 2006; Wu et al., 2007). In such cases, the right and anterior portal veins are replaced by their respective branches. From the current study, a prevalence of 18% is reported in which the right posterior portal vein was missing following the quadrification of the right portal vein. In such cases, the right posterior PV was replaced by the right posterior superior and posterior inferior branches. This further highlights the high variability of the portal venous system in a black Kenyan population. It should thus be borne in mind when performing surgical procedures in such a population.

In conclusion, we report significant variant anatomy of the right portal vein compared to those found in previous studies. This should be borne in mind when doing

surgical interventions involving the livers of the black Kenyan population.

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