The anatomical variations of the hepatic veins in a South African sample

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SUMMARY

A preoperative understanding of the anatomy of the hepatic veins and any variation thereof is pivotal for successful hepatic surgeries, as these vessels serve as a hepatic field guideline in living donor liver transplantations (LDLT) and hepatic resections. To date, numerous morphological variations in different populations other than a South African population have been published and thus the following research study was conducted to investigate and document morphological variations in a South African population. The following descriptive study aimed to contribute to a better preoperative understanding of hepatic vein anatomy impacting surgeries conducted in South Africa. This research study was conducted on 40 livers from donated bodies of 20 females and 20 males, used for academic purposes in the Department of Human Biology, at the University of Cape Town. The age range was between 33 to 105 years old with an average age of 75. The livers were removed, and the liver tissue was scraped away to expose the hepatic veins from their origin of the inferior vena cava (IVC) to their terminating branching points within the various hepatic segments. All the livers presented all three major hepatic veins, 90.0% of the livers had a common trunk (n = 36), and the remaining 10.0% had no common trunk (n = 4). The major and minor hepatic veins were observed for all the livers. This study found various morphological variations in a South African population that are of clinical significance with a high prevalence of accessory right hepatic veins.

Key words: Blood supply – Hepatic veins – Liver – Hepatic resection – LDLT

INTRODUCTION

A preoperative comprehension of the anatomy of the hepatic venous system is essential for ensuring successful hepatic surgeries and the preservation of hepatic venous drainage postoperatively (Singh et al., 2012; Nayak et al., 2016; Brentjies et al., 2018). This is seen to be true in advances in new surgical procedures such as living donor liver transplantations (LDLT), which was developed due to the need for donor livers exceeding the existing cadaveric supply and hepatectomies for patients with end-stage liver disease or cirrhosis (Cheng et al., 1997; Orguc et al., 2004; Uchida et al., 2010).

During the embryological gestation period, the hepatic diverticulum (liver primordium or liver bud) forms as a ventral outgrowth from the caudal portion of the endodermal wall of the foregut in the first three to four weeks (Bodzin, 2019; Mcpherson and Anthony, 2019; Sureka et al., 2019). The

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hepatic diverticulum then continues to enlarge, with the right lobe developing at a quicker rate than the left lobe and continues to divide into a cranial and caudal portion, forming the liver parenchyma and gallbladder respectively (Mcpherson and Anthony, 2019). During this period the liver receives its blood supply from the portal and umbilical veins, with the primordial portal veins developing from the caudal portion of the vitelline veins and the cranial portion forming the primordial hepatic veins (Bodzin, 2019).

Vitelline or omphalomesenteric veins are responsible for the transport of blood from the yolk sac to the sinus venosus (Ashworth, 2020). These veins mature to form the portal vein, anastomose across the duodenum, and traverse the septum transversum (Ashworth, 2020).

During the fifth week, the left cranial portion of the vitelline vein deteriorates, leaving the right proximal vitelline vein to merge with the cranial portion of the primary hepatic vein and gives origin to the three major hepatic veins, together with the hepatic portion of the inferior vena cava (IVC) (Sureka et al., 2019).

The major hepatic veins commonly consist of the right hepatic vein (RHV), middle hepatic vein (MHV), and left hepatic vein (LHV), which are responsible for draining the liver of deoxygenated blood through the suprahepatic portion of the IVC (Abdel-Misih and Bloomston, 2010; Sureka et al., 2019; Standring, 2021). The MHV and LHV commonly merge to form a common trunk, and the RHV is generally known to be the largest vein of the three major hepatic veins (Abdel-Misih and Bloomston, 2010). These veins are responsible for draining the different liver segments as classified by the Couinaud system which is founded on the anatomy of the biliary vasculature and surgical resectable sections (Mcpherson and Anthony, 2019; Standring 2021). Minor hepatic veins may consist of one to five vessels, exist in addition to the three major hepatic veins, and mostly drain the caudate lobe independently within the IVC (Standring, 2021).

The hepatic veins generally serve as a guide for the hepatectomy plane during surgery (Nayak et al., 2016). This is seen during hepatic surgeries such as LDLT where either the right or left liver segments as required by the recipient are removed and harvested from the living donor (Orguc et al., 2004). Anatomical variations should be considered to ensure the preservation of the hepatic venous outflow in both the recipient and donor as these variations could alter the hepatectomy field and surgical procedures accordingly (Cheng et al., 1997; Paspulati, 2017).

To date, numerous morphological variations within these hepatic veins have been studied in different populations, e.g., China, India, Turkey, etc. but studies regarding a South African population have not yet been found in the published literature. This study was performed to investigate and document morphological variations in a South African population and to analyze if sex or age was a contributing factor for the variations observed. This study ultimately aimed to contribute to a better preoperative understanding of hepatic vein anatomy that could impact surgeries conducted in South Africa.

MATERIALS AND METHODS

This was a cross-sectional observational study with a descriptive analysis within a cadaveric sample and was conducted in the dissection halls in the Department of Human Biology at the University of Cape Town. The sample consisted of 45 formalin preserved bodies. The livers were pre-dissected or removed from these bodies by undergraduate medical and postgraduate honors students during their academic training. The abdomen and relevant structures were dissected with the IVC dissected close to the diaphragm superiorly and close to the liver inferiorly. The attachments of the coronary, falciform, and triangular ligaments and surrounding fascia had also been dissected to freely retrieve the liver from the abdominal cavity during these dissections.

After removal, the livers were soaked in buckets of warm water and fabric softener – a fluid generally used to soften the fabric of clothes when washed (Britannica Dictionary), between 24-72 hours preceding the scraping of the liver tissue. The livers were submerged in a mixture of 10 liters warm water and a cap (75 ml) of liquid fabric softener that was mixed into the bucket of water to prevent the tissue from drying out and to help soften the liver tissue. The method of using fabric softener was utilized, as some liver tissue proved to be tougher compared to other livers and was sought to facilitate the softening of those liver tissues. Using the fabric softener together with the soaking process helped to ease the scraping and dissection of the liver tissue to expose the hepatic veins. The use of fabric softener has not yet been seen mentioned in the previous cadaveric studies such as those conducted by Shilal and Tuli (2015), Nand and Rai (2020), and Vinh Tran et al. (2020) to help with the ease of dissection to expose the hepatic veins under investigation.

After soaking, each liver was removed individually and placed on a block where the IVC, which was still intact, was cut open posteriorly. The exposed hepatic portion of the IVC served as a landmark for the origin and course for scraping the hepatic veins. The visceral peritoneum was removed by hand whereafter the superficial surface of the liver was scraped by a blunt scalpel to loosen the hepatic tissue. The tissue was then further scraped with both ends of a teaspoon and forceps which served as a curette, tracing the hepatic veins from their origin from the IVC to their terminating branches while taking care not to damage these vessels. Any vessels, hepatic arteries, portal, and biliary system or tissue that did not form part of the hepatic veins and obscured their course were removed by cutting them free with dissection scissors.

Five bodies were excluded after the livers from these bodies were investigated, and it was found that the hepatic veins were damaged. Of the remaining 40 bodies, that presented with intact and unaltered hepatic vein morphology; 50.0% (n = 20) were adult female individuals and the other 50.0% (n = 20) were adult male individuals that were included in this study. The age range of the sample was between 33 to 105 years old, and the average age was 75 with ± 14 standard deviations (SDs).

After dissection the hepatic veins were investigated to observe if all three major veins were found to be present, if the LHV and MHV drained via a common trunk into the IVC, which vein was observed to be the largest, and how many major and minor hepatic veins were found to be present together with any variations within these vessels. The vessels were classified using the Couinaud system. The MHV and Cantlie boundary-field amid the IVC and gallbladder fossa, divided the liver into a right and left lobe that was used to further classify hepatic veins as being the LHV, MHV, and RHV (Fig. 1, Mcpherson and Anthony, 2019).

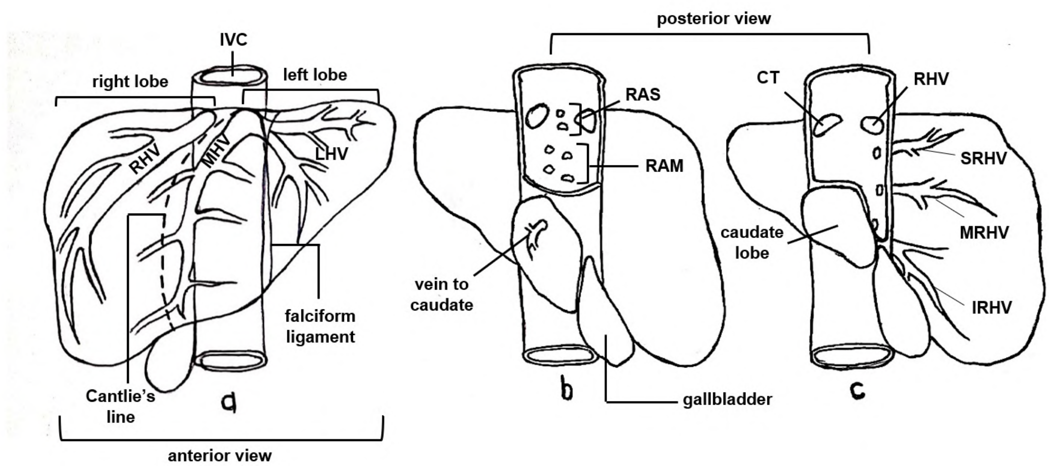

Fig. 1.- Illustration for the classification of hepatic veins documented in this research study. (**a**) Presents the anterior view of the liver separated into a left and right lobe by Cantlie's line and hepatic veins (RHV - right hepatic vein, MHV - middle hepatic vein, LHV - left hepatic vein) with relation to the inferior vena cava (IVC) and falciform ligament. Figure 1 b and c, represent the posterior and interior view of the liver and hepatic portion of the IVC, respectively. (**b**) Illustrates the nomenclature used for the minor hepatic veins found in relation to the MHV (RAS – right anterior superior veins, RAM – right anterior middle veins). (**c**) Illustrates the nomenclature used for the minor hepatic veins found in relation to the RHV and right posterior hepatic segment (SRHV – superior right hepatic vein, MRHV – middle right hepatic vein, IRHV – inferior right hepatic vein, CT – Common trunk of the LHV and MHV).

A common trunk for the LHV and MHV was identified and classified as such where the two vessels were seen to join and drain as one vessel within the IVC (Fig. 1), as opposed to the absence of a common trunk where these vessels were seen to drain separately into the IVC.

The major and minor hepatic veins were classified as per the description by Standring (2021) and counted. The minor hepatic veins that were smaller than the back tip of a dissection probe or those in which the origin and the course could not be traced were excluded.

Classification of any minor hepatic veins originating from the IVC and terminating within the hepatic tissue was achieved through the segmentation and sectioning of the liver. Vertical and horizontal planes exist that divide the right lobe into a right anterior and posterior section with four segments (V, VI, VII, & VIII) and the left lobe into a left medial and lateral section with three segments (II, III, IV; Couinaud system; Yip and Fenwick, 2013; Mcpherson and Anthony, 2019). These vessels that were found with the MHV were classified according to the section of the liver they were found to drain, namely the right anterior superior (RAS) and right anterior middle (RAM) segments (Fig. 1).

Minor hepatic veins that were found regarding the RHV and the right posterior section of the liver respectively were identified and classified when present as per the literature as the superior RHV (SRHV), middle RHV (MRHV), and inferior RHV (IRHV, Fig. 1). Any minor hepatic veins that drained the caudate lobe (hepatic segment I) were classified as the caudate veins (Fig. 1, Yip and Fenwick, 2013). Digital photographs were taken of the anterior and posterior aspects of the livers before and after dissections were carried out as part of the documentation for this study.

Statistical analysis

The statistical program IBM SPSS Statistics (version 27) was used to input and run statistical analysis for the data obtained. To test the significance within the categorical data for the incidence of the largest hepatic vein and the formation of a common trunk against sex of the population under study a Chi-Square Test was performed. Similarly, testing the significance of categorical and continuous variables; sex against age, the incidence of the largest hepatic vein against age, or the incidence of minor hepatic veins observed against sex, a One-Way ANOVA test was performed. Testing the significance within continuous variables such as the incidence of minor hepatic veins against age was achieved through performing a One-Sample T-Test.

A p-value < 0.05 and a confidence interval of 95.0% was used for all three of these tests to determine if the results were significant. These tests were mainly performed to test the significance of morphological findings when compared to the sex and age of the sample under study. For data to be tested for its significance with sex and age, no data had to be missing and the number of valid cases observed had to be five or more. Thus, data that did not meet the criteria together with observations that presented as a constant could not statistically be analyzed.

No ethical approval was needed as permission to use the bodies had already been granted by the Inspector of Anatomy in the Western Cape Government to the University of Cape Town for medical and research activities. All the bodies were handled ethically as outlined in the body donation program of the University and by strictly adhering to the Human Tissue Act of 2003.

RESULTS

For the 40 livers included in this study, all major hepatic veins (RHV, MHV, & LHV) were found to be intact and present. The formation of a common trunk between the MHV and LHV was found in 36 livers out of the 40 and in the remaining four livers these vessels drained separately into the suprahepatic portion of the IVC (Fig. 2). Variation for the length of the common trunk was seen and any junction even in the form of a common orifice (Fig. 2) of the MHV and LHV was classified as a common trunk.

The RHV was observed to be the largest hepatic vein followed by the MHV (Table 1; Fig. 3). It was seen that in three livers the LHV formed the largest hepatic vein, and there was one liver in which the RAM hepatic vein formed the largest hepatic vein (Table 1).

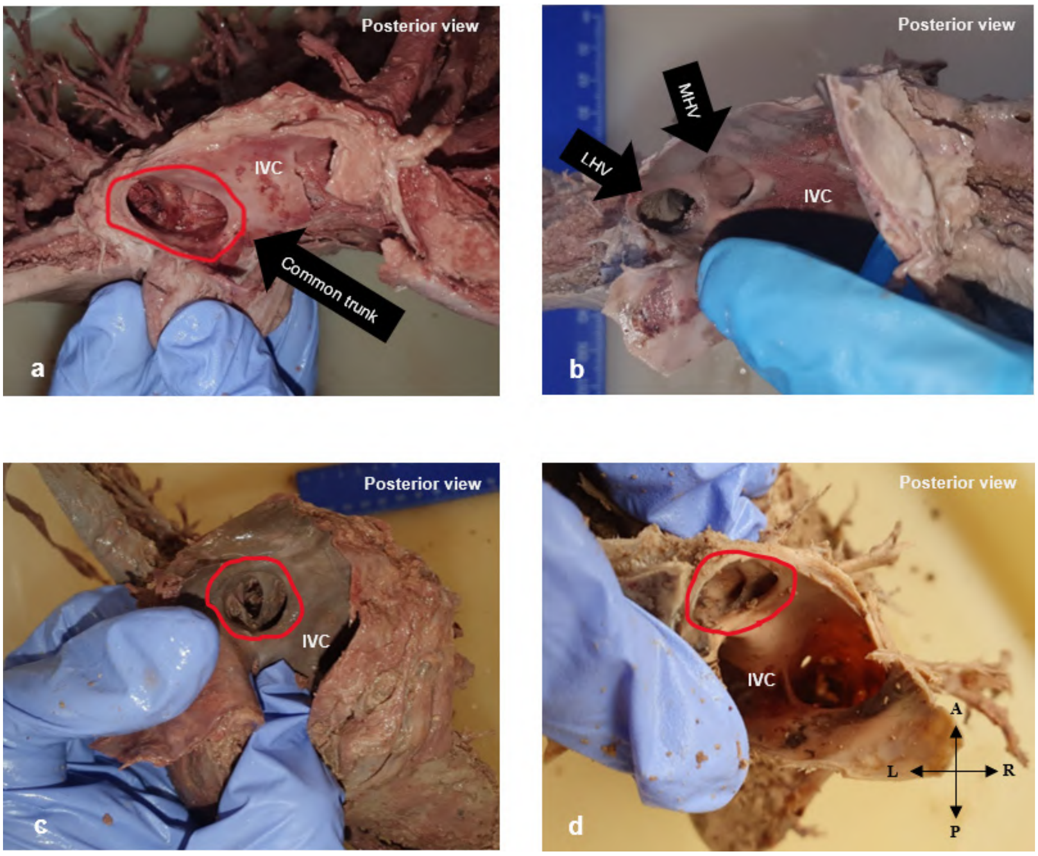

Fig. 2.- Occurrence and variation of a common trunk between the middle hepatic vein (MHV) and left hepatic vein (LHV). (**a**) Presents a common trunk between the MHV and LHV which drain as a single vessel into the suprahepatic portion of the inferior vena cava (IVC). (**b**) Indicates the absence of a common trunk between the MHV and LHV seen in this study and can be seen draining as two separate vessels into the IVC. (**c** and **d**) represent the incidence of variation for the length of a common trunk between the MHV and LHV and show these vessels sharing more of a common orifice**.** Arrow key: A – anterior; R- right; P – posterior; L- left.

The major hepatic veins were made up of two, three, or four vessels (Fig. 4) and were seen in 52.5% (*n* = 21), 32.5% (*n* = 13), and 15.0% (*n* = 6) respectively. Out of these vessels, accessory veins were found in 7.5% (*n* = 3) through an additional LHV, in 2.5% (*n* = 1) through the presence of a RAM hepatic vein, in 10.0% (*n* = 4) through the presence of a single MRHV, and in 5.0% (*n* = 2) through the presence of a single IRHV. The presence of these accessory veins contributed to a higher incidence of vessels classified as major hepatic veins than expected when a common trunk was present or absent.

Table 1. The largest major hepatic veins.

Hepatic vein	Frequency	Percentage
LHV	3	7.5%
MHV	13	32.5%
RHV	23	57.5%
RAM	1	2.5%
Total	40	100.0%

The minor hepatic veins ranged from two to nine with one incidence of 13 veins (Fig. 5a). A large proportion of livers presented with two to five minor hepatic veins, followed by seven and eight minor hepatic veins, and the remaining numbers of hepatic veins (6, 9, 13) were observed for a smaller proportion of the livers investigated (Fig. 5a). The further subdivision and classification of the minor hepatic veins revealed that: caudate veins were present in all livers, 12.5% (*n* = 5) had RAS hepatic veins, 55.0% (*n* = 22) had RAM hepatic veins, 60.0% (*n* = 24) presented the SRHV, 57.5% (*n* = 23) presented the MRHV, and 55.0% (*n* = 22) presented the IRHV.

The veins that originated from the IVC and coursed to terminate within the caudate lobe ranged from one to five vessels (Fig. 5b). The highest incidence was recorded for one to two veins seen in 77.5% (*n* = 31), followed by the remaining vessels being three to four in count seen in 17.5% (*n* = 7), and lastly five vessels in count seen in 5.0% (*n* = 2).

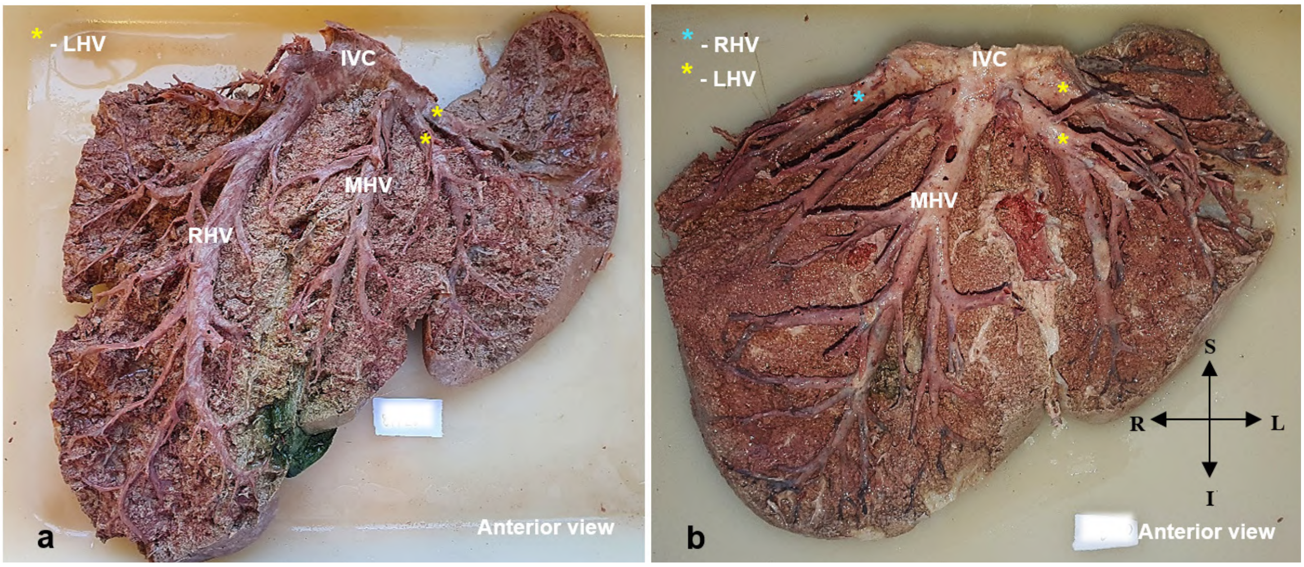

Fig. 3.- Representation of the largest hepatic vein observed for this research study. (**a**) Representing the incidence of the right hepatic vein (RHV) as the largest hepatic vein for the respective liver, draining into the inferior vena cava (IVC) in relation to the middle and left hepatic veins (MHV & LHV). (**b**) Representing the incidence where the middle hepatic vein was observed to be the largest. Arrow key: S – superior; L – left; I – inferior; R – right

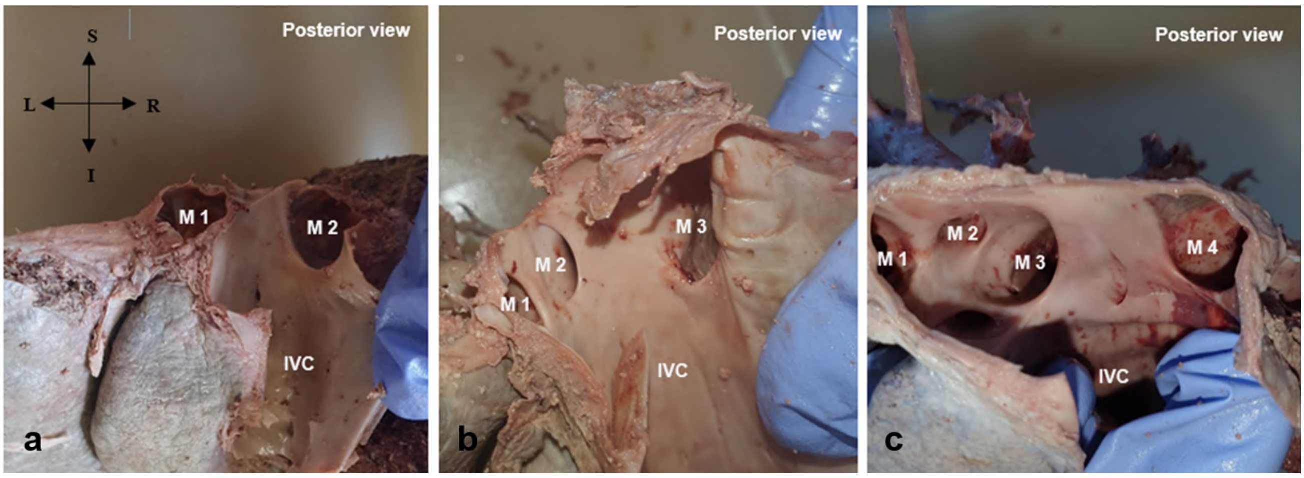

Fig. 4.- (**a-c**) Presence of the major hepatic veins (M) seen in this research study. These vessels can be seen to drain individually into the inferior vena cava (IVC) posteriorly and were counted as M1, M2, M3, or M4. Arrow key: S – superior; R – right; I – inferior; L – left.

Out of the 22 livers that had RAM hepatic veins (Fig. 5c), the veins were mostly present as one single vessel in 30.0% (*n* = 12) of the livers, followed by two to three vessels present in 12.5% (*n* = 5, respectively) of the livers. The presence of one single RAS hepatic vein was only seen in 12.5% (*n* = 5) of the livers included in this research study (Fig. 6). Most livers 87.5% (*n* = 35) did not have any RAS hepatic veins.

The presence of accessory right hepatic veins was observed for most of the livers and was either seen together as SRHV, MRHV, & IRHV; SRHV & MRHV; SRHV & IRHV; MRHV & IRHV respectively, or as one single vessel (Fig. 7). The presence of the SRHV out of the accessory right hepatic veins observed was present in 50.0% (*n* = 20) of the livers as one single vessel or as two vessels in 10.0% (*n* = 4) of the livers (Table 2).

Observations for the MRHV ranged from one to three vessels with the majority seen to have only one single vessel in 37.5% (*n* = 15) of the livers, followed by two vessels in 17.5% (*n* = 7) of the livers, and only one liver had three vessels (Table 2). The presence of the IRHV was mostly seen for 47.5% (*n* = 19) of the livers as one single vessel or two vessels in 7.5% (*n* = 3, Table 2).

Table 2. The prevalence of the accessory right hepatic veins.

Number of Veins	Frequency	Percentage
Superior		
0	16	40.0%
1	20	50.0%
2	4	10.0%
Middle		
0	17	42.5%
1	15	37.5%
2	7	17.5%
3	1	2.5%
Inferior		
0	18	45.0%
1	19	47.5%
2	3	7.5%
Total	**40**	**100.0%**

DISCUSSION

The sample size presented to be a confounding factor that could have influenced the observations and frequencies obtained. Although, the sex of the sample was evenly distributed, and no significant difference was found between the sex and age of the sample. The study was subject to the author's interpretations and observations that could have altered the classification of variations, although classification systems were sought and utilized to minimize any bias. Furthermore, the fact that the major hepatic veins that were found to be present and intact for all the livers were beneficial in identifying accessory veins in this study. This is supported when compared to studies such as Nand and Rai (2020) where two specimens had no LHV for the 50 livers investigated.

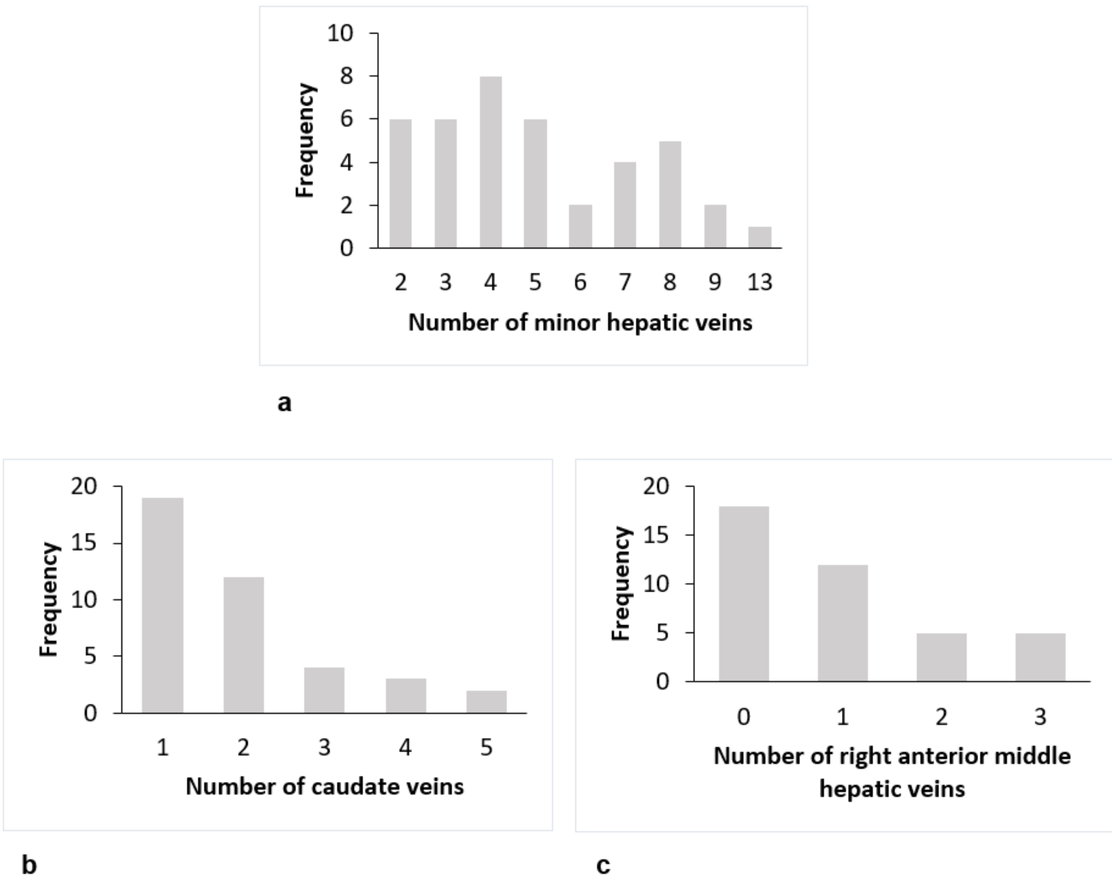

Fig. 5.- The occurrence of the specific hepatic veins under investigation for this research study, recorded as frequencies. (**a**) The frequency for the number of minor hepatic veins present in the livers investigated for this study. Figures 5b and 5c, illustrate the subdivision of the minor hepatic veins of figure 5a. (**b**) The frequency for the number of caudate veins present in the livers investigated for this study. (**c**) The frequency for the number of right anterior middle hepatic veins present in the livers investigated for this study.

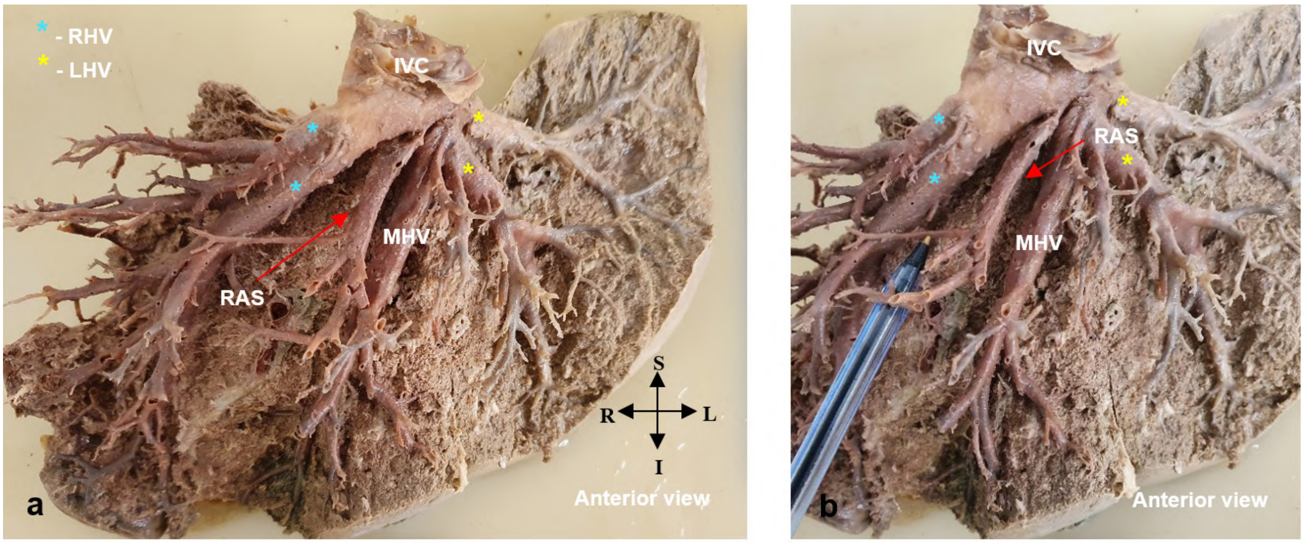

Fig. 6.- The incidence of the right anterior superior (RAS) hepatic veins observed in this study. (**a**) Presents the RAS hepatic vein indicated by the red arrow for the corresponding liver. It was seen to drain separately into the inferior vena cava (IVC) and course between the right hepatic vein (RHV) and middle hepatic vein (MHV) within the right anterior hepatic segment. (**b**) Shows a closer view of this vessel. Arrow key: S – superior; L – left; I – inferior; R – right.

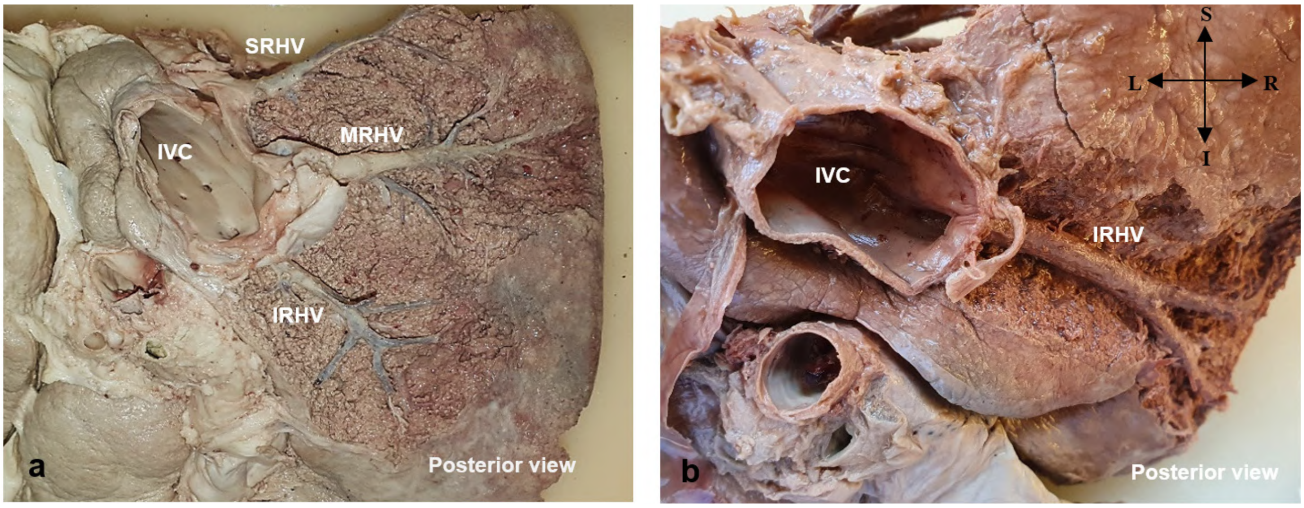

Fig. 7.- Representation of the accessory right hepatic veins observed in this research study. The veins were either all seen to be present as in (**a**), with the superior right hepatic vein (SRHV), middle right hepatic vein (MRHV), and inferior right hepatic vein (IRHV) or only one of these vessels were present as in (**b**) with the inferior right hepatic vein (IRHV). Arrow key: S – superior; R – right; I – inferior; L – left.

Morphological variations

The largest hepatic vein for this study was commonly found to be the RHV which agrees with the literature and general classification of the major hepatic veins (Abdel-Misih and Bloomston, 2010). For the LHV and MHV, contradictory results were found in this study when compared to that of Nand and Rai (2020). This study found the MHV to be the second largest vein to be observed and then the LHV, where Nand and Rai (2020) had opposite results with the LHV being the second largest (n = 10) and no observations for the MHV (n = 0).

Cheng et al. (1996) stated that the formation of a common trunk between the MHV and LHV is of significance during the resection of the left lateral segment of the left lobe together with the general incidence of the formation of a common trunk between the LHV and MHV. This is further supported by the results obtained from this study as well as other studies (Table 3). The major and minor veins accounted for were in line with the description by Standring (2021) and studies such as Nayak et al. (2016). However, Nayak et al. (2016) found six livers (7%) out of the 88 livers investigated that did

Table 3. Literature review results for the formation of a common trunk between the middle hepatic vein and left hepatic vein in cadaveric and clinical studies.

Author/s & Year	Study type	Sample size	Study Setting	Common trunk	
				Yes	**No**
Soyer et al. (1995)	Imaging (CTAP)	69	France	57 (95%)	3 (5%)
Cheng et al. (1996)	Imaging (ultrasound)	200	Taiwan	140 (70%)	60 (30%)
Wind et al. (1998)	Cadaveric	64	France	54 (84%)	10 (16%)
Singh et al. (2012)	Cadaveric	60	North India	4 (7%)	56 (93%)
Kalaycı et al. (2014)	Imaging (CT)	100	Turkey	70 (70%)	10 (10%)
Ulziisaikhan et al. (2014)	Cadaveric	40	Mongolia	31 (76%)	9 (24%)
Sureka et al. (2019)	Imaging (MDCT)	500	India	405 (81%)	95 (19%)
Nand and Rai, (2020)	Cadaveric	50	India	38 (76%)	9 (18%)
Vinh Tran et al. (2020)	Cadaveric	20	Vietnam	18 (90%)	2 (10%)
Total		**1303 - 32* = 1271**		**939 (74%)**	**332 (26%)**

*Number of livers excluded due to vessels being absent or undetectable.

not have any minor hepatic veins and were solely drained by major hepatic veins, whereas for the current study all the livers were found to be drained by minor and major hepatic veins.

Most minor hepatic veins for this study comprised accessory right hepatic veins where one or more of either one or all the SRHVs, MRHVs, and IRHVs were present. The presence of these veins was supported by previous studies in other populations (Table 4). For this study, the accessory right hepatic veins were mostly equally observed within the liver samples with the SRHV observed to have a slightly higher incidence level (60%), followed by the MRHV (58%) and IRHV (55%) respectively. This observation varies when compared to previous studies where the IRHV is found to greatly contribute to the right accessory hepatic veins (Table 4).

Morphological variation and clinical significance

Ensuring the preservation of the hepatic venous drainage after surgery proves to be of significance as venous obstruction and deferred hemorrhage have been noted (Fang et al., 2012). In the cases where the hepatic veins are partially or fully obstructed; Budd-Chiari syndrome, congestive hepatomegaly, and veno-occlusive diseases can develop (Fang et al., 2012). Thus, any variations encountered within the hepatic veins that could alter the hepatic venous outflow and drainage volume are of importance, especially in cases where the RHV is used as a graft and the presence of accessory veins and tributaries exist (Uchida et al., 2010).

The presence of accessory veins or tributaries from the RHV or MHV is of significance during resections of the right anterior or posterior segments of the right lobe (Sharma et al., 2019; Watanabe et al., 2020). This occurrence of accessory hepatic veins or tributaries is of importance as they could traverse the hepatectomy field and create a source of bleeding and graft ischemia when these vessels are damaged during surgery, leading to cardiac arrest or the origin of an air embolism (Shilal and Tuli, 2015; Paspulati, 2017). Furthermore, during the resection of the left lateral segment of the left lobe, the formation of a common trunk between the MHV and LHV is of significance as resection of the LHV should either be performed above or at the level of formation of the common trunk (Cheng et al., 1996).

The incidence of accessory right hepatic veins can be attributed to the embryological development where the ductus venosus and hepatic sinusoids are in direct contact with one another (Shilal and Tuli, 2015). As the gestation period comes to an end, this point of contact between the vessels generally atrophies, but it is believed that some regions maintain their connection and thus lead to the formation of accessory right hepatic veins such as the MRHV, IRHV, and SRHV (Shilal and Tuli, 2015).

Table 4. Literature review results for the incidence of accessory right hepatic veins in cadaveric and clinical studies.

Author/s & Year	Study type	Sample size	Setting	Accessory vein		
				MRHV	**IRHV**	**SRHV**
Cheng et al. (1997)	Imaging (ultrasound)	400	Taiwan	22 (6%)	72 (18%)	-
De Cecchis et al. (2000)	Cadaveric	110	Slovenia	-	23 (21%)	-
Akgul et al. (2004)	Imaging (CEHCT)	308	Turkey	-	65 (21%)	-
Orguc et al. (2004)	Imaging (CT)	100	Turkey	-	60 (60%)	-
Koc et al. (2007)	Imaging (MDCT)	1120	Turkey	-	356 (32%)	-
Uchida et al. (2010)	Imaging (CT)	223	Japan	-	90 (40%)	-
Fang et al. (2012)	Imaging (CT)	200	China	-	42 (21%)	-
Kalaycı et al. (2014)	Imaging (CT)	100	Turkey	36 (36%)	58 (58%)	44 (44%)
Shilal and Tuli (2015)	Cadaveric	60	India	-	46 (76%)	-
Sharma et al. (2019)	Imaging (CECT)	224	North India	-	126 (56%)	-
Sureka et al. (2019)	Imaging (MDCT)	500	India	-	185 (37%)	-
Nand and Rai (2020)	Cadaveric	50	India	-	27 (54%)	11 (22%)
Watanabe et al. (2020)	Imaging (CT)	307	Japan	-	197 (64%)	25 (8%)
Yang et al. (2020)	Imaging (CT)	299	China	-	103 (34%)	-
Cawich et al. (2021)	Imaging (CECT)	118	Trinidad and Tobago	5 (4%)	53 (45%)	-
Total		**4119 – 2473* = 1646**		**63 (4%)**	**1503 (91%)**	**80 (5%)**

*Number of livers excluded due to vessels being absent or undetectable.

When all these points are not taken into consideration, obstruction or ineffective hepatic resections or transplantations can occur and complications such as liver atrophy, infarction, septic shock, and diminished or no hepatic restoration have been seen to occur (Uchida et al., 2010).

CONCLUSION

The findings from the current research study revealed various morphological variations with a high prevalence of accessory right hepatic veins within a South African population. These morphological variations prove to be of clinical significance and contribute to the preoperative understanding of these vessels. Sex and age were not found to be contributing factors to the variations observed and future studies are recommended to further investigate specific aspects of these variations. Future studies could include a biometric study with different scraping techniques and casting or corrosion methods to better represent and measure these veins or an investigation into the relationship of the diameter of the RHV in comparison to that of the IRHV.

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