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Research Article

Dilation of the left renal vein: an indicator of spontaneous splenorenal shunt in chronic liver disease patients

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Abstract

Objectives: Spontaneous splenorenal shunts (SSS) in chronic liver disease (CLD) impact liver perfusion and prognosis post-liver transplantation. This study aims to identify radiological findings that predict the presence of SSS in CLD patients and to examine the relationship between SSS and left renal vein diameter.

Methods: A retrospective study was conducted on 150 adult patients evaluated for liver transplants from June 2018 to April 2021. The study groups included healthy controls (Group 1), CLD patients without SSS (Group 2), and those with SSS (Group 3). Multidetector CT angiography was used to measure the diameters of renal veins, portal vein, spleen size, and SSS.

Results: Significant differences were found between the groups for spleen size, splenic vein diameter, portal vein diameter, left renal vein diameter, and renal vein diameter difference, except for the right renal vein diameter. A left renal vein diameter of 10.5 mm or greater and both renal veins diameter difference of 0.5 mm or more favouring the left showed good diagnostic performance for predicting SSS, with area under the curve values of 0.828 and 0.833, respectively.

Conclusion: Dilation of the left renal vein and a greater diameter difference between renal veins favouring the left are strong indicators of SSS in CLD patients. These findings can aid in pre-transplant assessments and potentially improve post-transplant outcomes.

Advances in knowledge: This study establishes that an increased diameter of the left renal vein and a greater diameter difference between renal veins are reliable radiological indicators for predicting the presence of SSS in CLD patients.

Keywords: spontaneous splenorenal shunt; chronic liver disease; liver transplantation.

Introduction

Chronic liver damage and progressive fibrosis lead to liver cirrhosis and portal hypertension due to high hepatic vascular resistance.[1] Over time, portal hypertension causes portosystemic shunts.[2] Portosystemic shunts are collateral veins that form as compensation for portal hypertension and redirect blood flow to the systemic circulation.[1,3,4] Portosystemic shunts are most seen in the lower paraesophageal area, umbilical vein location, perirectal area, perisplenic area, and as splenorenal shunts.[3,5] Spontaneous splenorenal shunts (SSS) develop between the splenic vein and the renal vein, reducing the pressure of the portal circulation through the left renal vein and the inferior vena cava. They are seen in ∼14%-60% of cirrhotic patients.[6,7]

The presence of a SSS shunt is associated with a decrease in portal vein diameter, recurrent hepatic encephalopathy, high Child-Pugh and model for end-stage liver disease (MELD) scores.[8-11] In patients indicated for liver transplantation, one of the factors affecting liver perfusion and the prognosis in the post-transplant period is the presence of a SSS.[9] Evaluating portosystemic shunts, particularly the SSS, is important during the pre-transplant assessment of the recipient.[12] It is crucial to radiologically evaluate and document large SSS in the preoperative period as they may reduce portal perfusion and affect graft regeneration after transplantation.[13,14] The amount of portal perfusion after transplantation should be sufficient for graft regeneration. Prior to surgery, the surgeon must be informed of the presence of these shunts, which may require closure during transplantation.

The aim of this study is to identify radiological findings that can predict the presence of SSS in patients with chronic liver disease (CLD) and to examine the relationship between SSS and the diameter of the left renal vein.

Methods

This research was approved by the Ethics Committee of our institution. Informed consent was obtained from all patients. The study was written in compliance with the Strengthening the Reporting of Observational Studies in Epidemiology Statement: guidelines for reporting observational studies.

Patients

Our retrospective study was conducted at our university hospital between June 2018 and April 2021. The inclusion

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criteria were being an adult (over 18 years old) and applying for liver transplantation either as a donor or a recipient. Based on these inclusion criteria, 3 groups were formed (a total of 150 patients, with 50 patients in each group):

1) Group 1: Healthy individuals with no CLD (control group).
2) Group 2: Patients with CLD without a splenorenal shunt (SSS).
3) Group 3: Patients with CLD with an SSS.

Exclusion criteria:

- For Group 1:
  1) Presence of any liver or kidney pathologies.
  2) Splenomegaly.
  3) Insufficient images for evaluation.
- For Groups 2 and 3:
  1) Pathology affecting the left kidney.
  2) Patients who underwent liver transplantation (13 from Group 2 and 15 from Group 3).
  3) Chronic renal failure.
  4) Kidney sizes smaller than normal.
  5) Insufficient images for evaluation.

CT protocol

Images were obtained using a multidetector CT with parameters of 100 kV, 300 mAs, and 1 mm collimation (*Somatom Sensation 16; Siemens Healthcare, Erlangen, Germany*). The images were acquired by injecting 120 cc of non-ionic contrast agent (300 mgI/100 mL) at a rate of 4 mL/s, followed by 40 mL of physiological saline solution at a rate of 4 mL/s through the antecubital vein using an automatic injector. CT images were taken in the arterial, portal, and hepatic venous phases (at 20, 45, and 80 s, respectively) following the contrast agent injection.

Evaluation of the images

In all groups, the diameter and variations of the left renal vein, the diameter of the right renal vein, the difference in diameter between the 2 renal veins, spleen size, splenic vein diameter, portal vein diameter, and the presence of SSS were evaluated from the multidetector computed tomography (CT) angiography images of the patients. The left renal vein diameter was measured 2 cm proximal to its confluence with the inferior vena cava from the axial plane (Figure 1). The left renal vein variations were classified into 3 types: preaortic renal vein (normal), retroaortic renal vein, and circumaortic renal vein. In cases with a circumaortic left renal vein, the diameters of the ventral and dorsal branches were measured separately, and their total was recorded (Figure 2). The right renal vein diameter was measured 1 cm proximal to its confluence with the inferior vena cava from axial sections. The diameter difference between the 2 renal veins was calculated. The spleen size was measured in the craniocaudal direction from the coronal plane. The portal vein diameter measurement was done at the level of the portal hilus from axial sections. The diameter of the SSS was measured 1 cm proximal to where it drains into the left renal vein from the coronal plane (Figure 3).

Statistical analysis

The mean and SD were used to express all continuous data, and frequencies were used to express all categorical data. Statistical significance was defined as $P < .05$. The analysis was performed using IBM SPSS v.21.0 software. Numerical parameters between groups were analysed using the Kruskal-Walli's test, and categorical data were analysed using the Chi-square test. Mann-Whitney U analysis was performed to investigate where the difference between groups originated. ROC analysis was applied to evaluate the diagnostic performance of the parameters.

Results

The size of the spleen, splenic vein diameter, portal vein diameter, left renal vein diameter, SSS diameter, the difference in diameter between renal veins, and distribution of the diameter of the right renal vein in the groups are shown in Table 1. In the comparison of these parameters between groups, all were found to be statistically significant except for the diameter of the right renal vein.

In pairwise comparisons between groups, the size of the spleen, the diameter of the left renal vein, and the difference in diameter between renal veins were found to be significantly different among all groups ($P < .05$). The portal vein diameter was significantly different between Group 1 and Group 2



Figure 1. Axial CT images of 2 separate healthy cases in the control group reveal left renal veins (red arrows) of normal calibre.

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($P < .05$), with the mean portal vein diameter being higher in Group 2. However, there was no significant difference between Group 1 and Group 3 ($P > .05$).

ROC analyses were performed to investigate the diagnostic performance of parameters, that showed statistically significant differences from the Kruskal-Walli's analysis, in predicting the presence of a SSS (Figure 4). The area under the curve values (AUC) were found as shown in Table 2.

According to the ROC analysis, the parameter with the highest AUC value was found to be the diameter difference between the renal veins. Sensitivity, specificity, diagnostic accuracy, positive, and negative predictive values were calculated for the diameter difference parameter between renal veins. When the difference in diameter between renal veins was 0.5 mm or higher in favour of the left renal vein, the AUC was calculated as 0.833 (confidence interval 0.765-0.901). With this threshold value, the sensitivity was 83%, specificity was 71%, negative predictive value was 86%, positive predictive value was 59%, and accuracy was 74% for predicting the presence of an SSS (Figure 5).

In the ROC analysis for the relationship between the diameter of the left renal vein and the presence of an SSS, when the diameter of the left renal vein was 10.5 mm or higher, the AUC was calculated as 0.828 (CI 0.756-0.901), with a sensitivity of 84% and a specificity of 71% (Figure 6).

In the ROC analysis between the diameter of the portal vein and SSS, it was determined that cases with smaller portal vein diameter were associated with larger SSS diameter (AUC: 0.632).

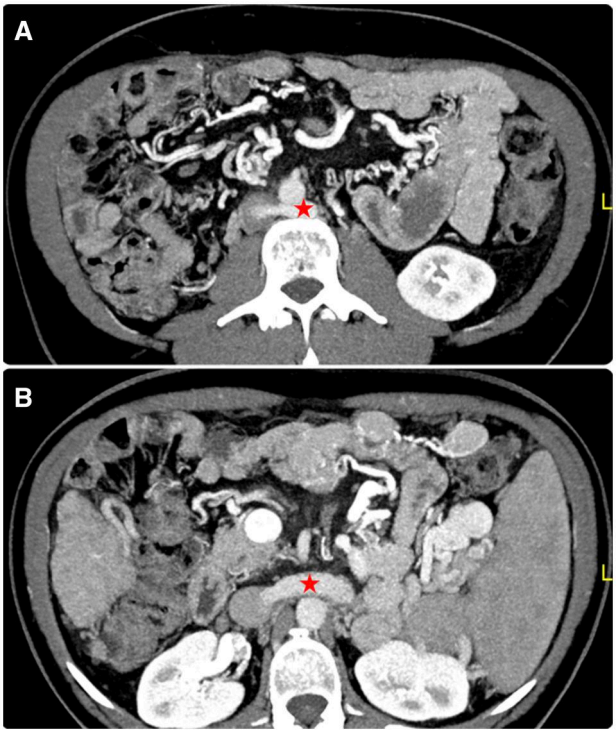


Figure 2. The dorsal (A) and ventral (B) branch (red asterisks) diameters of the circumaortic left renal vein were measured separately on axial CT images, and their total was recorded.

Discussion

In our study, it was demonstrated that dilation of the left renal vein in cases with CLD might indicate the presence of an SSS. A greater difference in diameter between the 2 renal veins, favouring the left, has good diagnostic performance in predicting the presence of a shunt. Specifically, a difference of 0.5 mm in favour of the left renal vein has been identified as a threshold that improves the diagnostic performance.

The presence of SSS in patients with CLD is a factor that worsens prognosis by increasing Child-Pugh and MELD scores, as well as mortality and morbidity.[7-9] These shunts located between the left renal vein and the splenic vein redirect spleen drainage into the left renal vein. As a result, the dilation of the left renal vein can appear as an indirect indicator of the shunt. Our study revealed a significant difference in the left renal vein diameter between cirrhotic patients with and without splenorenal shunts. This finding suggests that radiologists can interpret the dilation of the left renal vein as a warning sign for the presence of a splenorenal shunt when evaluating patients with CLD.

The mean right renal vein diameter of the control group was higher than the left renal vein. While it is known in the literature that an increase in the diameter of the left renal

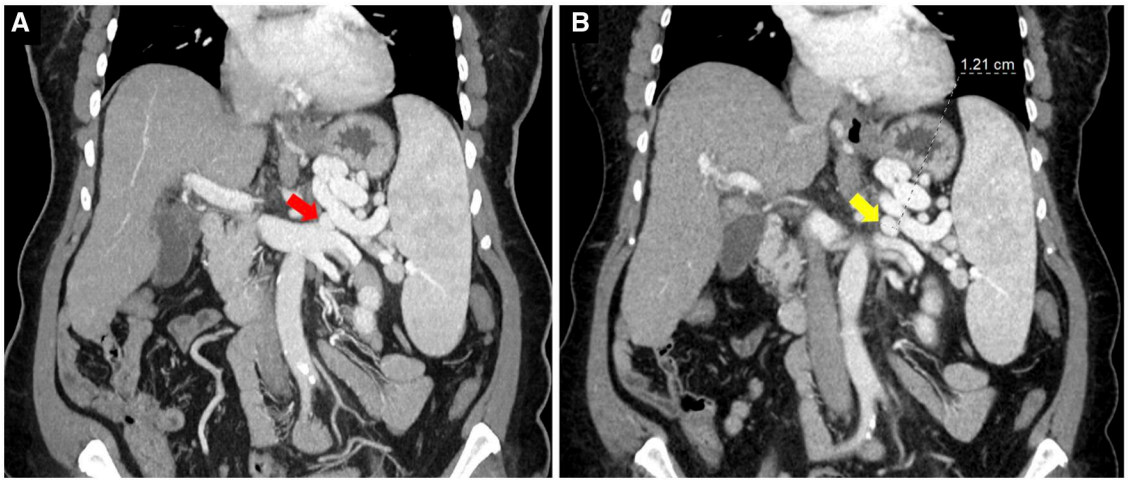


Figure 3. Coronal CT images show measurement of the SSS diameter at 1 cm proximal (B; yellow arrow) to where it empties into the left renal vein (A; red arrow).

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Table 1. Distribution of spleen size, splenic vein diameter, portal vein diameter, left renal vein diameter, splenorenal shunt diameter, diameter difference between renal veins (left-right), and right renal vein diameter in the groups.

Groups		Spleen size	Splenic vein diameter	Portal vein diameter	Left renal vein diameter	SSS diameter	DDBRV[a]	Right renal vein diameter
1. Control group	Mean	108.160	8.96	12.56	9.47	.000	−.5319	10.080
	Number of cases	50	50	50	47	50	47	50
	Standard deviation	11.1142	1.009	1.373	1.120	.0000	1.23096	1.2262
2. Group with SSS	Mean	161.660	10.71	13.58	10.82	.000	.2857	10.520
	Number of cases	50	48	48	49	50	49	50
	Standard deviation	27.9348	2.221	2.656	2.489	.0000	2.48328	1.8762
3. Group without SSS	Mean	175.431	11.82	11.47	13.19	11.902	3.0213	10.157
	Number of cases	51	49	45	47	51	47	51
	Standard deviation	29.8699	4.300	4.315	3.026	5.0961	3.18618	1.9532
Total	Mean	148.596	10.48	12.56	11.15	4.020	.9161	10.252
	Number of cases	151	147	143	143	151	143	151
	Standard deviation	37.9398	3.069	3.080	2.797	6.3681	2.85691	1.7174

[a]DDBRV = Diameter difference between renal veins.

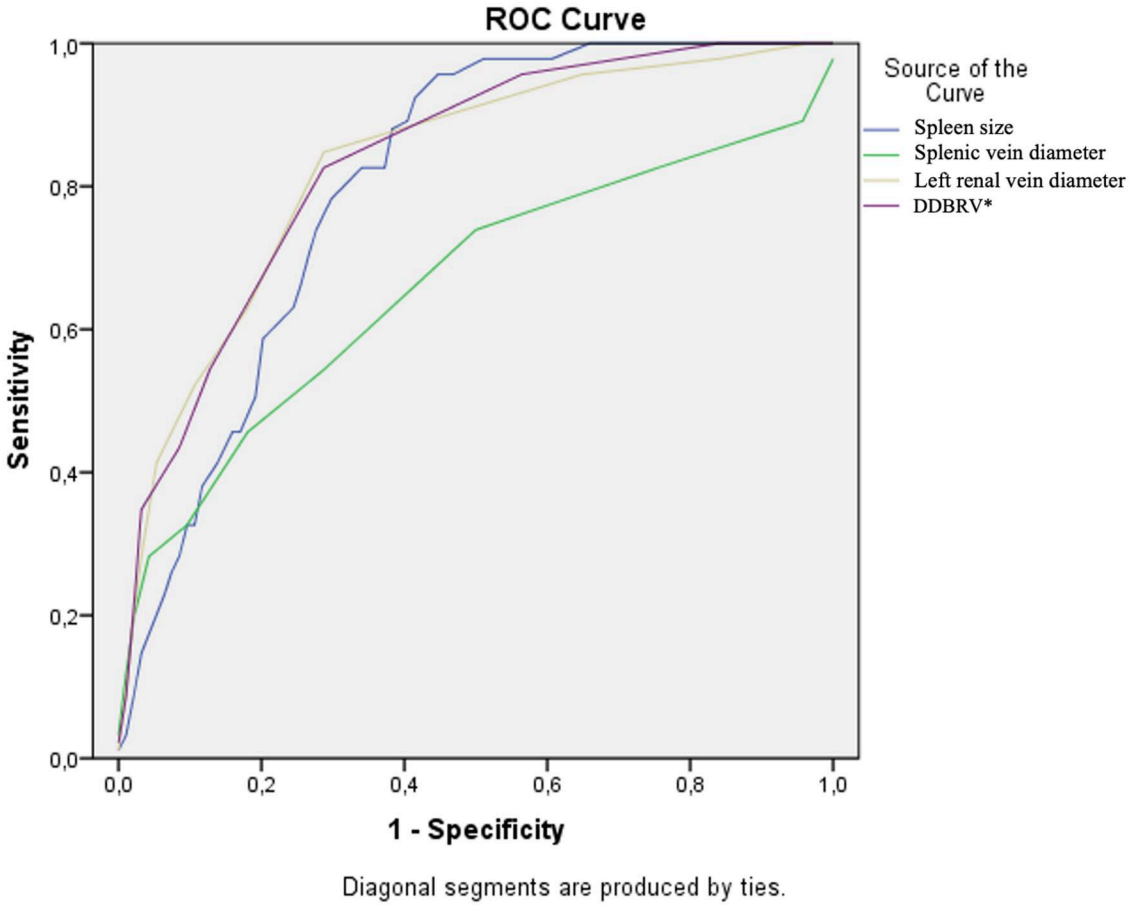


Figure 4. ROC analysis of spleen size, splenic vein diameter, left renal vein diameter, and diameter difference between renal veins.

vein raises suspicion of a splenorenal shunt, the threshold between the 2 renal veins was defined for the first time in our study.[15] In cases with CLD, when the diameter of the left renal vein is 0.5 mm or greater than that of the right renal vein; it has been demonstrated that the difference between the 2 veins has a good diagnostic performance in indicating the presence of a splenorenal shunt.

In the study by Bagheri et al. comparing Doppler ultrasound, and CT angiography for the diagnosis of SSS, they found that CT had higher sensitivity and specificity for SSS diagnosis.[15] According to their findings, when the diameter of the left renal vein was 10 mm or higher, CT demonstrated a sensitivity of 78.6% and a specificity of 67.9% for indicating the presence of SSS. In our study, when the left renal vein diameter was 10.5 mm or greater, the sensitivity for indicating the presence of SSS was found to be 84.8% and the specificity was 71%, which were higher values in comparison to the literature.

In our study, in terms of portal vein diameters; while there was a significant difference between the control group and

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cirrhotic patients without splenorenal shunt, there was no significant difference between the control group and cirrhotic patients with splenorenal shunt. In the study conducted by Yi et al. on cirrhotic patients, it was shown that there was a decrease in portal vein diameter in cases with splenorenal shunt.[8] Our findings, consistent with previous research, demonstrated that the presence of SSS was associated with a reduction in the diameter of the portal vein.

Table 2. Area under the curve values obtained from ROC analysis regarding spleen size, splenic vein diameter, left renal vein diameter, diameter difference between renal veins, and portal vein diameter.

Variables	AUC[a]	Standard deviation	*P* value	Confidence range (%95)	
				Lower limit	Upper limit
Spleen size	.803	.036	.000	.733	.874
Splenic vein diameter	.660	.054	.002	.555	.765
Left renal vein diameter	.828	.037	.000	.756	.901
DDBRV[b]	.833	.035	.000	.765	.901
Portal vein diameter	.632	.057	.011	.520	.744

[a]AUC = area under the curve;
[b]DDBRV = diameter difference between renal veins.

The strengths of this study are as follows: a detailed and comprehensive radiological assessment was conducted to determine the presence of splenorenal shunts in patients with CLD. The grouping of patients and the analysis of data were performed using reliable statistical methods. Advanced statistical techniques, such as ROC analysis, were utilized to evaluate the ability of radiological findings to predict the presence of shunts. In addition, it is important to consider the gaps in the literature in terms of SSS and the potential of this study to fill them. The results of this study can provide valuable information to clinicians for identifying the presence of SSS in patients with CLD and reducing the risk of transplant complications in these patients.

A total of 28 patients in groups 2 and 3 included in our study underwent liver transplantation. Knowing the shunts in these patients is important in reducing complications such as portal steal that may develop after transplantation.

Limitations of our study may include the retrospective design, limited number of patients, and possible bias in patient

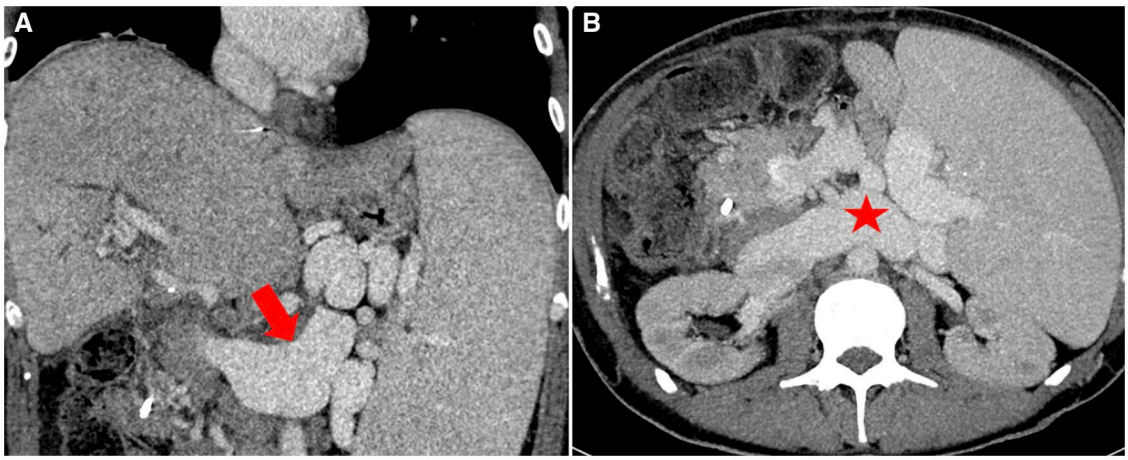


Figure 5. Coronal (A) and axial (B) CT images of a patient with CLD reveal a splenorenal shunt (arrow) and dilated left renal vein (red asterisk).

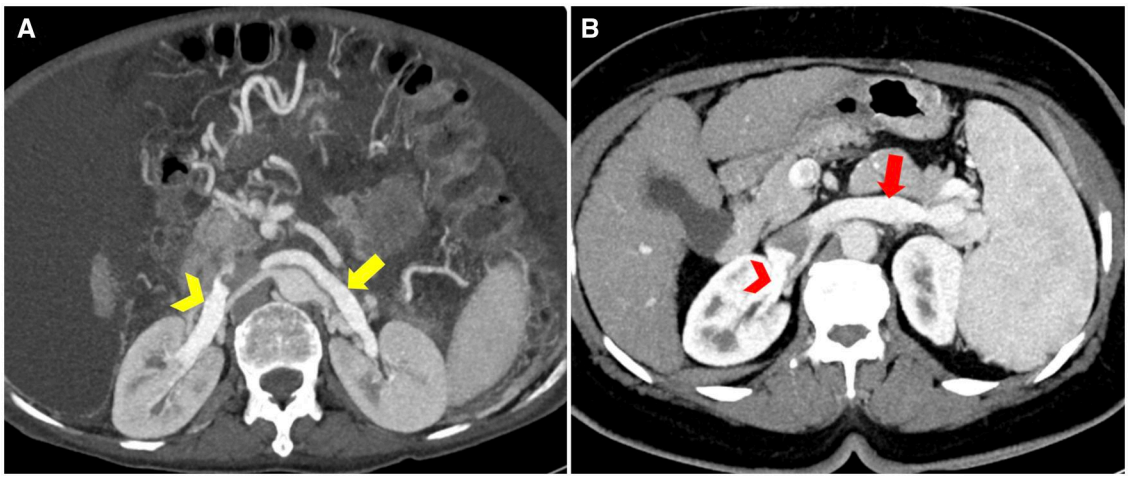


Figure 6. In the axial CT images of 2 separate cases with CLD; in the case without splenorenal shunt (A), the left renal vein (yellow arrow) is smaller in diameter than the right renal vein (yellow arrowhead), in the case with splenorenal shunt (B), the left renal vein (red arrow) is larger than the right renal vein (red arrowhead).

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selection. The retrospective nature of the study implies the collection and evaluation of data retrospectively, potentially resulting in some information loss. The sample size is limited, and the study was conducted in a single centre, which restricts the generalizability of the results. Methodological differences or errors in radiological measurements could affect the accuracy of the results. The heterogeneity among patients may make it difficult to interpret the results and draw general conclusions.

Conclusion

In conclusion, our study demonstrated that dilation of the left renal vein in patients with CLD may indicate the presence of SSS, and an increase in the diameter difference between the 2 renal veins, favouring the left, has good diagnostic performance in predicting the presence of an SSS.

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Conflicts of interest

The authors declare that they have no conflict of interest.

Ethics approval

The ethical guidelines were strictly adhered to and laid out in the Declaration of Helsinki by the World Medical Association. The study was sanctioned by the Koç University's ethics committee.

References

1. Simón-Talero M, Roccarina D, Martínez J, et al. Association between portosystemic shunts and increased complications and mortality in patients with cirrhosis. *Gastroenterology*. 2018;154:1694-1705.e4. https://doi.org/10.1053/j.gastro.2018.01.028
2. Zardi EM, Uwechie V, Caccavo D, et al. Portosystemic shunts in a large cohort of patients with liver cirrhosis: detection rate and clinical relevance. *J Gastroenterol*. 2009;44:76-83. https://doi.org/10.1007/s00535-008-2279-1
3. Yi F, Guo X, Zeng QL, et al. Computed tomography images of spontaneous portosystemic shunt in liver cirrhosis. Marasco G, ed. *Can J Gastroenterol Hepatol*. 2022;2022:3231144-3231113. https://doi.org/10.1155/2022/3231144
4. Nardelli S, Riggio O, Gioia S, Puzzono M, Pelle G, Ridola L. Spontaneous porto-systemic shunts in liver cirrhosis: clinical and therapeutical aspects. *World J Gastroenterol*. 2020;26:1726-1732. https://doi.org/10.3748/wjg.v26.i15.1726
5. Arora A, Rajesh S, Meenakshi YS, Sureka B, Bansal K, Sarin SK. Spectrum of hepatofugal collateral pathways in portal hypertension: an illustrated radiological review. *Insights Imaging*. 2015;6:559-572. https://doi.org/10.1007/s13244-015-0419-8
6. Qi X, Qi X, Zhang Y, et al. Prevalence and clinical characteristics of spontaneous splenorenal shunt in liver cirrhosis: a retrospective observational study based on contrast-enhanced computed tomography (CT) and magnetic resonance imaging (MRI) scans. *Med Sci Monit*. 2017;23:2527-2534. https://doi.org/10.12659/MSM.901656
7. Achiwa S, Hirota S, Kako Y, Takaki H, Kobayashi K, Yamakado K. Radiological anatomy of spontaneous splenorenal shunts in patients with chronic liver disease. *Jpn J Radiol*. 2017;35:206-214. https://doi.org/10.1007/s11604-017-0623-1
8. Yi F, Guo X, Wang L, et al. Impact of spontaneous splenorenal shunt on liver volume and long-term survival of liver cirrhosis. *J Gastroenterol Hepatol*. 2021;36:1694-1702. https://doi.org/10.1111/jgh.15386
9. Saks K, Jensen KK, McLouth J, et al. Influence of spontaneous splenorenal shunts on clinical outcomes in decompensated cirrhosis and after liver transplantation. *Hepatol Commun*. 2018;2:437-444. https://doi.org/10.1002/hep4.1157
10. Rogal SS, Hu A, Bandi R, Shaikh O. Novel therapy for non-cirrhotic hyperammonemia due to a spontaneous splenorenal shunt. *World J Gastroenterol*. 2014;20:8288-8291. https://doi.org/10.3748/wjg.v20.i25.8288
11. Maruyama H, Kondo T, Kiyono S, Sekimoto T, Takahashi M, Yokosuka O. Influence of splenorenal shunt on long-term outcomes in cirrhosis. *Scand J Gastroenterol*. 2015;50:593-600. https://doi.org/10.3109/00365521.2014.1003401
12. Castillo-Suescun F, Oniscu GC, Hidalgo E. Hemodynamic consequences of spontaneous splenorenal shunts in deceased donor liver transplantation. *Liver Transpl*. 2011;17:891-895. https://doi.org/10.1002/lt.22304
13. Takayasu K, Moriyama N, Shima Y, et al. Sonographic detection of large spontaneous spleno-renal shunts and its clinical significance. *Br J Radiol*. 1984;57:565-570. https://doi.org/10.1259/0007-1285-57-679-565
14. Iannello S, Libertini L, Martini R, et al. A large spontaneous splenorenal shunt in a patient with liver cirrhosis and uncomplicated portal hypertension. *Dig Dis*. 1999;17:248-255. https://doi.org/10.1159/000016944
15. Bagheri M, Hajati A, Hosseini M, Ostad SP. Comparison of findings of spontaneous splenorenal shunt in color Doppler sonography with multislice CT scan (64 slices) in liver transplant candidates. *Eur J Radiol*. 2012;81:2027-2036. https://doi.org/10.1016/j.ejrad.2011.06.008

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