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Computed Tomography Images Based Measurement of Caudate to Right Lobe Ratio of Liver in Adult Population in a Tertiary Care Hospital

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ABSTRACT

Background

Liver volume changes in cases of liver cirrhosis due to enlargement in caudate lobe and shrinkage in the right lobe. The caudate-to-right lobe ratio is essential for assessing liver volume redistribution. The caudate-to-right lobe ratio value <0.6 is normal, between 0.6 and 0.65 is borderline, >0.65 suggests cirrhosis and over 0.73 is cirrhotic in 99% cases. Aim of this study was to analyze the morphometric measurement of the liver and calculate caudate-to-right lobe ratio in the Nepalese population using contrast-enhanced computed tomography and compare the values with previously documented studies to provide baseline data.

Methods

This analytical cross-sectional study was performed from September 2023 to September 2024 after ethical clearance (Ref. No.: 296/080/081(6-11) E2). Data (measurement of the transverse diameter of the caudate and right lobe) of all patients undergoing contrast-enhanced computed tomography examination of the abdomen without any liver pathology necessitating the examination during the study period. The caudate-to-right lobe ratio was calculated from the measurement. Data were analyzed using the SPSS (version 16).

Results

Among the 200 cases, 88 (44.00%) were male and 112 (56.00%) were female. We found 46 years (IQR: 25-75) as median age of the participants. The mean liver span, transverse diameter of the caudate lobe, right lobe, and caudate-to-right lobe ratio were 12.34±1.24 cm, 3.71±0.60 cm and 8.40±0.80 cm and 0.45±0.08 respectively.

Conclusions

The caudate-to-right lobe ratio was found 0.45±0.08 in normal adult study population. The caudate-to-right lobe ratio was found not correlated with age or sex.

Keywords: computed tomography; caudate-to-right lobe ratio; liver.

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INTRODUCTION

Liver morphometry varies among sex, race, and different geographic population.[1-3] Anatomically, the liver is divided into different lobes.[4,5] Its greatest transverse and vertical measurement varies from 20 to 26 cm and 15 to 21 cm respectively.[6] Liver disease is a major public health challenge and is globally distributed. The caudate-to-right lobe (C/RL) ratio is applied to assess changes in liver volume, commonly in cirrhosis. Measurement of the C/RL ratio (an important morphological marker) is crucial for the early diagnosis of liver cirrhosis. A C/RL ratio above 0.65 is one of the indications of cirrhosis.[7-10] As the C/RL ratio is a valuable tool in diagnosing cirrhosis, its value for the normal population should be known. In this regard, the C/RL ratio for the normal Nepalese population is lacking. Thus, the purpose of this study was to measure liver dimensions and to calculate C/RL ratio among normal adults using Computed Tomography Scanner.

METHODS

This study was analytical cross-sectional. This study was carried out in the patients undergoing contrast-enhanced computed tomography (CECT) examination of abdomen as a part of the diagnostic procedure and referred for contrast-enhanced computed tomography abdomen examinations in the Department of Radiology and Imaging, Tribhuvan University Teaching Hospital. This study was conducted between September 05, 2023 and September 06, 2024 after obtaining ethical clearance from the Institutional Review Committee (IRC), Institute of Medicine, Tribhuvan University (Ref. No.: 296/080/081(6-11) E2). To evaluate the C/RL ratio, all the patients (200) undergoing contrast-enhanced computed tomography examination of the abdomen without any liver pathology necessitating contrast-enhanced computed tomography examinations of abdomen as a part of diagnostic procedure and referred for contrast-enhanced computed tomography examinations of abdomen in the Department of Radiology and Imaging, Tribhuvan University Teaching Hospital were included in the study. However, patients with portal system malformations, metallic implants affecting the evaluation, and images of the patients with technical inadequacy like motion artifact, motion blurring were excluded from the study. A total of two hundred patients were included in this study using total population sampling (images of all the patients meeting the inclusion criteria) during the study period. Data were acquired using the 128-slice Siemens SOMATOM Definition AS multi-detector computed tomography (MDCT) machine after getting informed consent either from the patient of legal age or from their closed relatives. All patients were screened according to the protocol of the department and presence of any external radiopaque substance in the region of interest was removed and patients were positioned on the table of 128-slice multi-detector computed tomography scanner. The contrast-enhanced computed tomography examinations of abdomen was performed in the standard protocol of the radiology department (collimation = 64 x 0.625 mm, effective mAs =230, 120kVp, pitch=0.891, rotation time = 0.75 second, and image matrix = 512 X 512).

After completion of scanning all the images so obtained were evaluated for any liver pathology, motion artifact, and motion blurring. Measurement of liver span, the caudate and right lobe of liver were taken on the computed tomography computer monitor using the technique used by Harbin et al.[8] All the measurements were taken using linear distance measuring tool on 1mm thick contrast enhanced axial image showing the bifurcation of the main portal vein with window width 300 and window level 40 to avoid intra-observer or inter-observer variability in the measured value which would influence or impact the findings. Horizontal diameter of caudate lobe and transverse diameter of the right lobe were recorded separately. Similarly, measurement of liver span (maximum cranio-caudal distance) was taken on 1mm thick coronal reformatted contrast enhanced image with window width 300 and window level 40 to avoid intra-observer or inter-observer variability in the measured value at the level of the largest dimensions of liver. Finally, C/ RL ratio of liver was calculated

using the following formula: C/RL ratio=horizontal diameter of the caudate lobe divided by the horizontal diameter of right lobe.

Socio-demographic variables, liver span, diameter of the caudate lobe, diameter of the right lobe and C/RL ratio were recorded using predesigned pro-forma. Analysis of data was done using the SPSS (version 16). For descriptive statistics, mean value and standard deviation (SD) were calculated. Categorical variables were described as percentage. The p-value less than 0.05 was kept for level of significance. Statistical analysis was performed by using independent t-test to compare mean diameter of caudate lobe, diameter of the right lobe, liver span and C/RL ratio between male and female. Correlation of diameter of caudate lobe, diameter of the right lobe and C/RL ratio with age were tested with Karl Pearson's coefficient correlation test.

RESULTS

Two hundred patients following under inclusion criteria were taken in the study. Age of patients ranged between 18 and 79 years with a median age 45 years (IQR: 25-76 years). Among the total patients, 88 (44.00%) were males and 112 (56.00%) were females (Table 1).

In this study, the C/RL ratio, liver span, the transverse diameter of the caudate lobe and transverse diameter of the right lobe were 0.45 ±0.08, 12.34 ±1.24 cm, 3.71±0.60 cm, and 8.40±0.80 cm, respectively. The liver span and C/RL ratio of male were 12.49±1.35 cm and 0.45±0.08 and that for female were 12.21±1.14 cm and 0.44±0.07, respectively. Similarly, transverse diameter of the caudate and the right lobes of male were 3.83±0.64 cm and 8.57±0.74 cm and that for female were 3.62±0.54 cm and 8.26±0.82 cm, respectively. There was no significant difference between the mean value of liver span and C/RL ratio for males and females (p-value>0.05) whereas the mean differences in the diameter of the caudate lobe and the diameter of the right lobe between male and female were found to be significant (p-value <0.05) (Table 2).

There was no significant correlation between the transverse diameter of the caudate lobe of the liver and age (Pearson correlation coefficient=0.06 and p-value=0.39). Likewise, the correlation between the transverse diameter of the right lobe and age was not statically significant, as Pearson correlation coefficient was found 0.04 (p-value=0.58). Similarly, no significant correlation was found between C/RL ratio and age, as the Pearson correlation coefficient was found to be 0.09 (p-value=0.22). Also, the correlation between liver span and age was observed to be insignificant, as the Pearson correlation coefficient was found to be 0.03 (p-value=0.60) (Figure 1).

Table 1. Distribution of the study population according to age and sex. (n=200)

Sex	Frequency (%)	Age group (years)					
		18-28	29-38	39-48	49-58	59-68	≥69
Male	88(44.00)	12(13.60)	17(19.30)	13(14.80)	23(26.10)	10(11.40)	13(14.80)
Female	112(56.00)	18(16.10)	32(28.60)	19(17.00)	21(18.80)	10(8.90)	12(10.70)

Table 2. Distribution of liver span, transverse diameter of the caudate lobe, right lobe, and the caudate-to-right lobe ratio in both sexes. (n=200)

Sex	Computed tomography measurements of liver (mean value ±SD)			
	Liver span (cm)	Transverse diameter of the caudate lobe (cm)	Transverse diameter of the right lobe (cm)	Caudate lobe-to-right lobe ratio
Male	12.49±1.35	3.83±0.64	8.57±0.74	0.45±0.08
Female	12.21±1.14	3.62±0.54	8.26±0.82	0.44±0.07
p-value	0.11	0.02	0.01	0.51
t-value	1.61	2.43	2.7	0.66

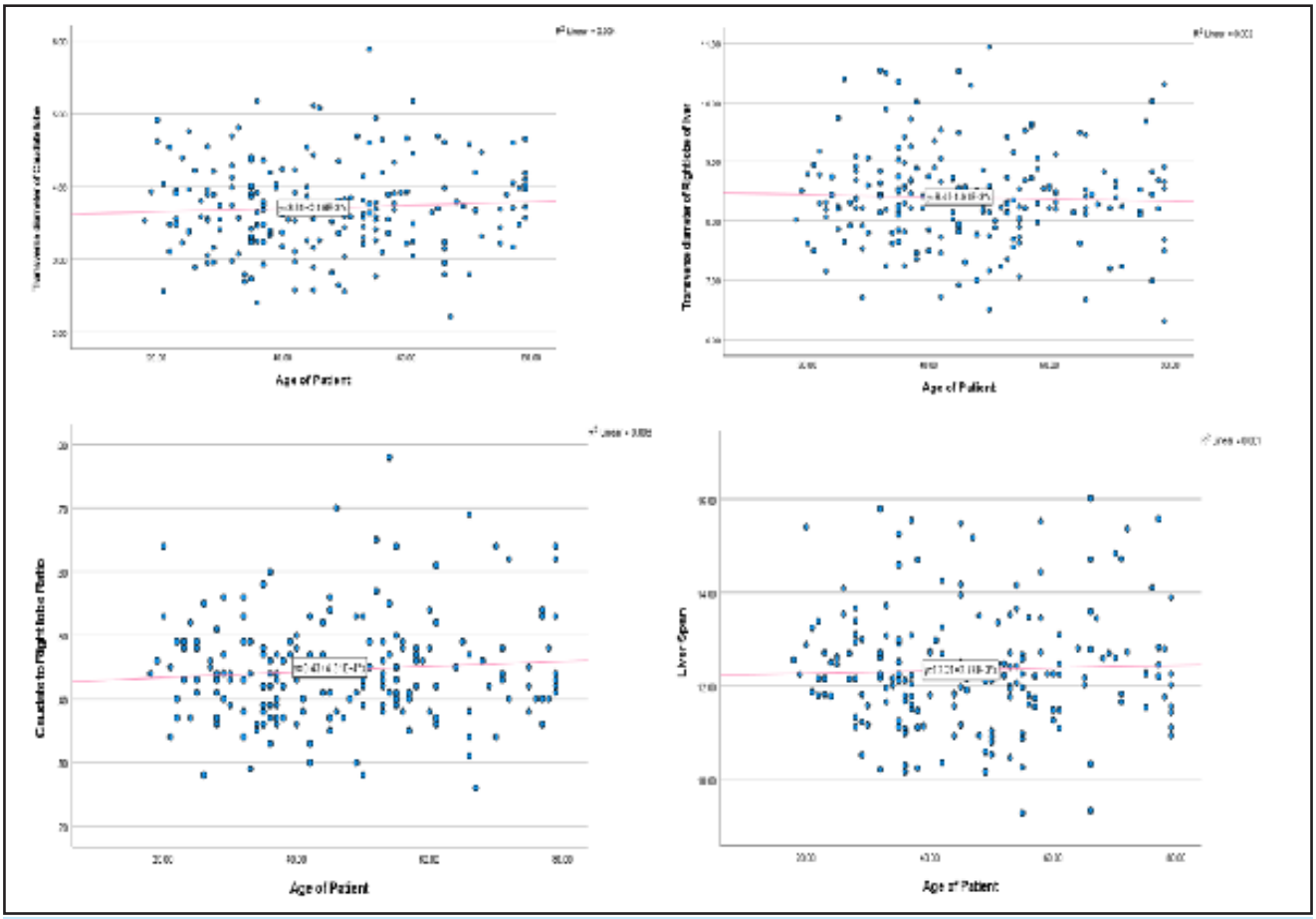

Figure 1. Correlation of the transverse diameter of the caudate lobe, right lobe, caudate-to-right lobe ratio, and liver span with the age of participants.

DISCUSSION

Accurate assessment of liver dimensions is of utmost importance in the evaluation of suspected hepatic pathologies.[1] The measurement of the C/ RL ratio (a key morphological marker) is vital for the early diagnosis of liver cirrhosis and, a C/RL ratio below 0.60 is normal whereas that above 0.65 indicates the probability of the presence of cirrhosis.[12]

Our study aimed to analyze the morphometric measurements of the caudate lobe, right lobe, liver span and, C/RL ratio in Nepalese adults with normal liver. In this study, the C/RL ratio was found 0.44±0.08 (0.45±0.08 for male and 0.44±0.07 for female) and the liver span found was 12.33±1.24 cm (12.49±1.35 cm in male and 12.21±1.14 cm in females). There was a statistically insignificant difference in the C/RL ratio and the liver span between males and females, as (p-value=0.51 and p-value=0.11, respectively). Similarly, the diameter of caudate lobe and right lobe measured were 3.71±0.59 cm (3.83±0.64cm in male and 3.62±0.54 cm in female) and 8.39±0.79 cm (8.57±0.74 cm in male and 8.26±0.82 cm in female), respectively. A significant difference in the transverse diameter of caudate lobe and right lobe between male and female was found (p-value=0.02 and p-value=0.01, respectively). There was no correlation between the transverse diameter of the caudate lobe, right lobe, caudate-to-right lobe ratio, and liver span and age of the participant.

Contractor et al. evaluated 100 cadaveric livers of humans and found that the transverse diameter of caudate lobe 2.87±0.77 cm, right lobe 7.82±1.22 cm, liver span 12.96±3.77 cm and C/RL ratio 0.38±0.12. The values of the transverse diameter of the caudate lobe, right lobe, and C/RL ratio were slightly lower than those found in the current study, but the value for liver span was slightly higher than that in our study.[13] These differences may be due to difference in race

Table 3. Comparison of liver span, transverse diameter of the caudate lobe, right lobe, and the caudate-to-right lobe ratio among different studies across the world.

Researcher (Country)	Sample size (n)	Liver span (cm)	Right lobe size (cm)	Caudate lobe size (cm)	C:RL Ratio
Contractor JB et al. (India)	100	12.96±3.77	7.82±1.21	2.87±0.77	0.38±0.12
Ilione T et al. (Nigeria)	107	15.74±1.00	8.51±0.70	3.78±0.50	0.44±0.00
Balla EA et al. (Sudan)	20	12.74±1.16	11.79±1.13	5.39±0.52	0.45±0.04
Kim YS et al. (Korea)	66	-	8.87±0.88	3.96±0.56	0.45±0.07
Current Study	200	12.33±1.24	8.39±0.79	3.71±0.59	0.44±0.08

or difference in measuring method. A similar study by Sagoo et al. on preserved livers of two different populations, Indian and UK Caucasian, also found that the mean transverse diameter of right lobe 8.06±1.01 cm and 8.82±1.09 cm, respectively. This difference may be due to either difference in race or geographic location.[14] A similar study by Ilione T et al. based on computed tomography images in 107 cases in Nigeria found higher transverse diameter of the caudate lobe (3.78±0.50 cm), right lobe (8.51±0.70 cm), and liver span (15.74±1.00 cm), but similar C:RL ratio and (0.44±0.00). The high measured value may be due to differences in body size and race. Ilione T et al. also found no significant difference in liver span and C/RL ratio between male and female patients, which supports the results of our study. However, they also found no significant difference in the transverse diameter of the caudate lobe and right lobe between male and female patients, which is in contrast to our study in this regard.[7] A similar study based on USG by Balla EA et al. in 20 cases in Sudan found higher values for the transverse diameter of the caudate lobe (3.39±0.52 cm) and right lobe (11.79±1.13 cm) in contrast to our study result but found similar liver span (12.74±1.16 cm) and C/RL ratio (0.45±0.04) that support the current study results in this regard.[15] Kin YS et al. performed a similar study based on computed tomography images in 66 healthy Koreans and found similar values for the transverse diameter of the caudate lobe (3.96±0.56 cm), right lobe (8.87±0.88 cm), and C/RL ratio (0.45±0.07) and also found no significant difference in C/RL between male and female, which supports the results of our study. Kin YS et al. also found no correlation between C/RL and the age of patients, which is again in the line with our study's result[9-12] (Table 3).

Although we took complete population following the inclusion criteria during the study period, all the patients under 18 years were excluded. Thus, the results of this study cannot be useful for children or people under 18 years. Additionally, the current study did not compare the study variables (liver span, transverse diameter of the caudate lobe, right lobe and caudate lobe-to-right lobe ratio) of patients with healthy liver with those diagnosed with liver cirrhosis.

CONCLUSIONS

Our study confirms 0.44±0.08 as C/RL ratio as the baseline for adult healthy Nepalese. There is a deviation in liver dimensions (liver span, transverse diameter of caudate lobe, and right lobe) compared with other similar studies in other countries.

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REFERENCES

1. Shrestha E, Thapa NB, Tayal A. Assessment of Normal Liver Size among Adults by Ultrasonography in Kathmandu Medical College. Nepalese Journal of Radiology. 2021 Dec 31;11(2):37-42. [DOI]
2. Chan SC, Liu CL, Lo CM, Lam BK, Lee EW, Wong Y, Fan ST. Estimating liver weight of adults by body weight and gender. *World J Gastroenterol* 2006; 12(14): 2217. [Google Scholar]
3. Drvendzija Z, Stosic S, Srdic Galic B, Radosevic

D, Udicki M, Bodiroga D, Neskovic N. Liver Size and its Correlation with Anthropometric Parameters and Age. International Journal of Morphology. 2023 Nov 1;41(6). [Google Scholar]

4. Sah SK, et al. Study of Variations in the Morphology of Liver in the Nepalese Cadavers. J Human Anatomy. 2020, 4(1): 000145. [Link]
5. Prasad RJ, Amgain K, Shah TN. Morphological Variations and Morphometric Analysis of the Caudate Lobe of Liver: A Cadaveric Study. Journal of Nepalgunj Medical College. 2021 Dec 31;19(2):71-4. [Google Scholar]
6. Haaga JR, Boll DT. CT and MRI of the whole body. Philadelphia: Elsevier; 2017. [Textbook]
7. Ilione T, Ohagwu CC, Ogolodom MP. Computed tomography evaluation of the caudate-to-right lobe ratio in patients with liver cirrhosis and subjects with normal liver in Benin City, Edo State, Nigeria. Health Science Journal. 2019;13(5):1-7. [Link]
8. Giorgio A, Amoroso P, Lettieri G, Fico P, De Stefano G, Finelli L, Scala V, Tarantino L, Pierri P, Pesce G. Cirrhosis: value of caudate to right lobe ratio in diagnosis with US. Radiology. 1986 Nov;161(2):443-5. [Google Scholar]
9. Awaya H, Mitchell DG, Kamishima T, Holland G, Ito K, Matsumoto T. Cirrhosis: modified caudate–right lobe ratio. Radiology. 2002 Sep;224(3):769-74. [Google Scholar]
10. Ye H, Wang Q, Huang H, Zhao K, Li P, Liu Z, Wang G, Liang C. L-distance ratio: a new distance ratio-based evaluation method for the diagnosis of cirrhosis using enhanced computed tomography. Quantitative Imaging in Medicine and Surgery. 2023 Jan 9;13(3):1499. [Google Scholar]
11. Harbin WP, Robert NJ, Ferrucci JT. Diagnosis of cirrhosis based on regional changes in hepatic morphology: A radiological and pathological analysis. Radiology. 1980;135(2):273–83. [Google Scholar]
12. Kim YS, Jeong BR, Kim KS. Caudate to right lobe ratio of normal liver by computed tomography. Journal of the Korean Radiological Society. 1987 Aug 1;23(4):604-7. [Google Scholar]
13. Contractor JB, Patel VD, Vaniya VH. Harbin's index: Morphological evaluation of caudate-to-right lobe ratio in human cadaveric liver. Journal of The Anatomical Society of India. 2021 Jul 1;70(3):168-72. [Google Scholar]
14. Sagoo MG, Aland RC, Gosden E. Morphology and morphometry of the caudate lobe of the liver in two populations. Anatomical science international. 2018 Jan;93(1):48-57. [Link]
15. Balla EA, Abdo MA, Ayad CE. Evaluation of caudate and right hepatic lobes ratio in patients with Schistosoma mansoni using ultrasound in Al-Fao area. Indian Journal of Scientific Research. 2013;4(1):11-6. [Link]

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