International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Research Article

A Morphometric Analysis of Harbin's Index in Human Cadaveric Livers

Deepa Devadas[1], Amit Kumar Nayak[2], Anjana Sharma[3], Mrinmayee Deb Barma[4]

[1] Associate Professor, Department of Anatomy, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India
[2] Associate Professor, Department of Anatomy, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India
[3] Senior Resident, Department of Anatomy, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India
[4] Assistant Professor, Department of Anatomy, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

OPEN ACCESS

Corresponding Author:

Deepa Devadas

Associate Professor, Department of Anatomy, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Received: 17-09-2025
Accepted: 05-10-2025
Available online: 20-10-2025

ABSTRACT

Background: Cirrhosis is a chief cause of morbidity and mortality in patients with chronic liver disease worldwide, accounting to about 2.2% global deaths. Of the various morphological features and signs used to diagnose cirrhosis, the caudate-right lobe ratio or Harbin's Index has been found to show high specificity for accurate diagnosis. **Materials & Methods:** 60 adult human cadaveric livers were included in the study. The morphometric measurements of caudate lobe and right lobe widths were performed using digital vernier calipers. The Harbin's Index was calculated as the ratio of caudate lobe width to width of right lobe of liver respectively and the data was statistically analyzed. **Results:** The average width of the caudate lobe was found to be 28.38 ± 6.81mm, with values ranging from 12.36 mm to 45.6 mm respectively. Average right lobe width was found to be 93.62 ± 11.18 mm with a range of 64.47 mm to 116.85 mm respectively. Harbin's index calculated as ratio of caudate to right lobe widths was found to show a mean value of 0.31 ± 0.09 with maximum value of 0.71 and minimum value of 0.16 respectively. No statistically significant correlation was found to exist between caudate and right lobe widths respectively. **Conclusion:** Cirrhotic livers often show right lobe atrophy with compensatory hypertrophy of caudate lobe. Harbin's Index values >0.65 have been globally accepted as indicative of liver cirrhosis.

Keywords*: Liver; Caudate lobe; Right lobe; Morphometry; Harbin's Index*

INTRODUCTION:

The liver, the largest solid organ in human body, is affected by several pathologies and diseases. Among the various known liver pathologies, cirrhosis is known to be a major culprit associated with deteriorating liver function, causing subsequent morbidity and mortality. Cirrhosis has been ranked as a significant cause of mortality and morbidity, contributing to 2.2% of deaths along with 1.5% of disability-adjusted life years globally (Cheemerla,2021). Histologically, the liver responds to chronic liver injury with cirrhotic changes by forming regenerative nodules enclosed by fibrous bands, resulting in portal hypertension and terminal stage liver disease (Schuppan,2008).

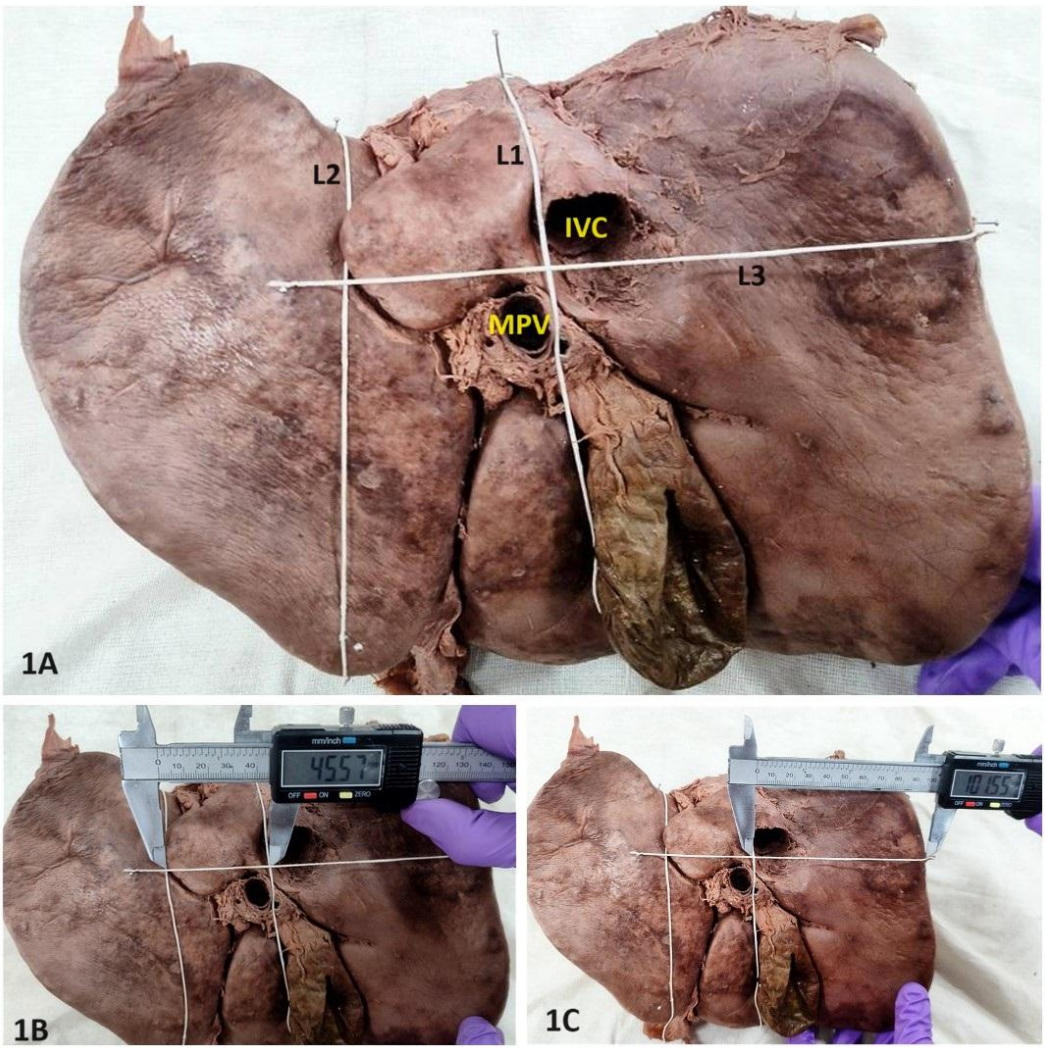
Though liver biopsy still reigns as the standard investigation of choice for diagnosis, it causes considerable discomfort to the patient with its own fair share of complications as an invasive procedure. Hence the usage of non-invasive diagnostic markers in liver cirrhosis has gained popularity and significance over the years. The caudate-right lobe ratio, known as Harbin's index is one such non-invasive diagnostic tool that has demonstrated relatively high specificity and accuracy in the diagnosis of cirrhosis (Contractor, 2021). The present study is an attempt to morphometrically assess the Harbin's index in cadaveric livers and add to the presently existing data in scientific literature.

MATERIALS & METHODS:

The current research was carried out in Department of Anatomy, Institute of Medical Sciences, Banaras Hindu University on donated cadavers for research purposes. The authors state that every effort was made to follow all local and international

ethical guidelines and laws that pertain to the use of human cadaveric donors in anatomical research (Iwanaga,2022). This was a descriptive observational study which was done on 60 adult cadaveric livers obtained from Anatomy Department during routine teaching of undergraduate medical students. The liver specimens were removed en bloc from cadavers during routine dissection classes along with the retro-hepatic segment of the inferior vena cava (IVC). Livers showing evidence of disease, traumatic injury and surgical resection as well those which were distorted in shape were excluded from the study. The 60 livers which were finally selected were then placed in anatomical position and the caudate and right lobes of liver were identified.

Hepatic measurements were performed individually by both authors using vernier calipers (digital) and threads (cotton), according to the method followed by Contractor et al (Contractor, 2021).
3 lines were marked on the liver using cotton threads as follows:
[Ref. Fig 1A]



*IVC – Inferior Vena Cava † MPV – Main portal vein

Fig.1A: Showing Various hepatic Measurements; 1B: Measurement of caudate lobe width; 1C: Measurement of Right lobe width

(i) Line 1 (L1): passing through the right lateral margin of the main portal vein (MPV)
(ii) Line 2 (L2): passing through the medial most limit of caudate lobe, parallel to Line 1
(iii) Line 3 (L3): Perpendicular to both the above (lines 1 & 2), midway between MPV and IVC, up to the lateral limit of right lobe

Caudate lobe width (CW), was measured as distance on line 3, between lines 2 and 1. [Ref. Fig 1B]
Right lobe width (RW), was measured as distance along line 3, from Line 1 up to the lateral most limit of the right lobe. [Ref. Fig 1C]

Statistical Analysis

Harbin's Index was subsequently calculated as ratio of caudate lobe width to width of right lobe (CW/RW). The findings thus obtained were documented and statistically analyzed using SPSS software, version 24. A two tailed bi-variate Pearson correlation test was also run with caudate lobe width and right lobe width as two variables.

RESULTS:

The average width of the caudate lobe (CW) was found to be 28.38 ± 6.81mm, with values ranging from 12.36mm to 45.6mm respectively. Average right lobe width (RW) was found to be 93.62 ± 11.18mm and ranged from 64.47mm to 116.85mm respectively.

The mean value of Harbin's index (CW/RW) was calculated to be 0.31 ± 0.09 with minimum and maximum values of 0.16 and 0.71 respectively. Pearson correlation value was found to be 0.088. Although an extremely small positive correlation can be seen, value is less than 0.1 and significance is 0.5 (>0.05). Therefore, the authors conclude that no statistically significant correlation exists between the above two values. [Ref. Table 1]

Table No.1: Pearson Correlation between Right lobe width and Caudate lobe width

		Right lobe width
Caudate lobe Width	**Pearson Correlation**	0.088
	Sig. (2-tailed)	0.504
	N (sample size)	60

DISCUSSION:

The caudate-right lobe ratio, also known as Harbin's index (Harbin,1980), was first demonstrated by Harbin et al in a radio-pathological study on histologically proven cases of liver cirrhosis. Harbin observed a consistent finding of caudate lobe enlargement with concomitant right lobar fibrotic shrinkage in cirrhotic livers of his study. The caudate-right lobe ratio, was thus calculated as the ratio of width of caudate lobe to width of right lobe. Harbin concluded that a caudate-right lobe ratio of < 0.6 shall be considered as within preferable range and that > 0.65 is indicative of liver cirrhosis, while values between 0.6 to 0.65 are considered as borderline (Harbin,1980). The Harbin's index has been found to be a very useful non-invasive diagnostic tool for cirrhosis demonstrating 84% sensitivity, 100% specificity, and 94% accuracy respectively (Bolog,2009).

In our study, Mean Harbin's index was calculated as 0.31 ± 0.09. The average CW and RW was measured as 28.38 ± 6.81mm and 93.62 ± 11.18 mm respectively. A comparison of our findings with studies done in other parts of India and studies done worldwide has been presented in Table 2 (A &B).

Table No. 2: Comparative table showing findings of present study with other parts of India and world

Table 2A: Comparative table showing findings of present study with other parts of India

Parameter	Present study	Roy & Basu, 2022 (West Bengal)	Contractor, 2021 (Gujarat)	Sagoo, 2018 (Punjab)	Syamala,2019 (Andhra Pradesh)	Arora, 2016 (Bareilly)
Sample Size	60	51	100	50	50	36
Mean Caudate width (mm)	28.38	24.5±0.54	28.69 ± 7.73	27.4 ± 1.22	25.8 ± 0.75	27
Mean Right lobe width (mm)	93.62	81±0.93	78.22 ± 12.17	80.6 ± 1.06	73.9 ± 1.19	114.3
Harbin's Index	0.31 ± 0.09	0.30	0.38±0.12	0.34 ± 0.15	0.17± 0.08	0.16

Table 2B: Comparative table showing findings of present study with other populations of the world

Parameter	Present study	Oguz & Gunduz, 2023 (Turkey)	Gardner, 2019 (Caribbean)	Ilione , 2019 (Nigeria)	Sagoo, 2018 (UK)	Harbin, 1980 (North America)
Sample Size	60	196	56	214 (107 cirrhotic, 107 controls)	25	65

Mean Caudate width (mm)	28.385	40.4 ± 0.59	32.17 ± 6.30	52.5 ± 0.91 (cirrhotic); 37.8 ± 0.56 (controls)	23.6 ± 0.75	
Mean Right lobe width (mm)	93.62	88.6 ± 1.07		72.3 ± 1.03 (cirrhotic); 85.1 ± 0.72 (controls)	88.2 ± 1.09	
Harbin's Index	0.31	0.46 ± 0.08	0.34 ± 0.066	0.72 ± 0.06 (Cirrhotic), 0.44 ± 0.05 (controls)	0.27 ± 0.1	0.83 ± 0.20 cirrhotic; 0.37 ± 0.16 normal

The caudate lobe, which is classified as first Couinaud's Segment, is unique in its vascular supply and biliary drainage, being thus considered as an independent functional unit of liver. The bile duct, portal vein and hepatic artery form two relatively constant right and left pedicles in the caudate lobe (Ilione,2019). As both hepatic lobes contribute to the formation of caudate lobe in embryonic period, it receives vascular supply from both hepatic arteries and portal veins (Contractor, 2021). The caudate arteries arises from both left & right hepatic arteries, along with middle hepatic arteries when present (Roy & Basu, 2022; Arora 2016). The left and right branches of the portal vein also contribute to the blood supply of the caudate lobe. Up to 78% of the biliary drainage from the caudate lobe may be received by both left and right hepatic ducts (Kumon,1985). The venous drainage also requires special mention. In addition to the three well known main hepatic veins that open into the IVC, the venous blood from caudate lobe also flows into several minor hepatic veins that release into the IVC independently of the main hepatic veins (Roy & Basu, 2022; Arora 2016). This unique caudate vascular anatomy with inflow and outflow features establishes a system in which the caudate lobe is differentially affected in cirrhosis and other liver pathologies.

Since caudate lobe is drained by multiple small veins opening directly into inferior vena cava, impeded blood flow through hepatic veins in cirrhotic livers causes an upsurge of blood flow into the caudate lobe leading to hypertrophy frequently associated with atrophy of the right or left lobes (Watanabe,1999). Also, the formation of cirrhotic nodules and fibrotic changes along with development of portal hypertension compromises the blood supply resulting in atrophy of the right lobe thus elevating the values of Harbin's Index in cirrhotic patients. It has also been suggested that differences in various hormones, hepatotropic and nutritional factors in portal circulation between caudate and other hepatic segments may further contribute to hyperplastic changes in the caudate lobe (Becker,1986).

The caudate lobe has been known to have great regenerative capacity (de Hemptinne, 2024; Choi,2008 Van Minh,1992; Kumon,1985). With its distinctive and well organised affluent and effluent blood flow mechanisms, the caudate lobe functions like a backup liver, thus helping prevent hepatic failure with its own independent vascularization and ability for regeneration (Choi,2008 Van Minh,1992). Studies have shown that caudate lobe size is consistent with hepatic functional reserve in cirrhotic patients with enlarged caudate lobe being observed as a frequent finding in cases of compensated cirrhosis as compared to decompensated cirrhosis (Schuppan,2008; Choi,2008; Kumon,1985). A relatively lesser hypertrophied caudate lobe with right lobe atrophy in cirrhotic patients has been considered as an indication of impending hepatic failure. This may attribute to the reason why caudate lobe hypertrophy and subsequently raised Harbin's index values may actually have a protective effect by preventing hepatic failure and is often seen in cases of compensated liver cirrhosis. Measurement of the Harbin's index can thus serve as an important tool for assessing hepatic functional reserve in cirrhotic patients for deciding further course of therapy.

Limitations of the Study

Our study has been performed on cadaveric livers. A simultaneous correlation with radiological images of normal subjects as well as chronic liver disease patients can offer greater clarity regarding the diagnostic significance of the Harbin's Index. The future of our research will be oriented in this direction.

CONCLUSION:

The Harbin's index serves as a very useful non-invasive parameter in investigation and diagnosis of cirrhosis with great specificity and accuracy. The present study has examined the values of Harbin's index (caudate-right lobe ratio) in cadaveric, normal livers of Eastern Uttar Pradesh population. A knowledge of these normal morphometric values can help in quicker assessment and early diagnosis of cirrhotic liver disease, leading to improved clinical care and better treatment outcome in the long run.

Acknowledgements: Fund No. R/Dev/D/IoE/Equipment/Seed Grant-II/2022-23/67630 granted to Dr Deepa Devadas by IOE Cell, BHU is gratefully acknowledged

Funding: No. R/Dev/D/IoE/Equipment/Seed Grant-II/2022-23/67630 granted to Dr Deepa Devadas is gratefully acknowledged

List of Abbreviations
IVC – Inferior Vena Cava
MPV – Main Portal Vein
CW – Caudate lobe width
RW – Right lobe width

REFERENCES

1. Arora, N. K., Srivastava, S., Haque, M., Khan, A. Z., & Singh, K. (2016). Morphometric Study of Caudate Lobe of Liver.
2. Becker, C. D., Scheidegger, J., & Marincek, B. (1986). Hepatic vein occlusion: morphologic features on computed tomography and ultrasonography. *Gastrointestinal radiology, 11*(1), 305-311.
3. Bolog, N., Oancea, I., Andreisek, G., Mangrau, A., & Caruntu, F. (2009). Diagnosis performance of different MR imaging signs of cirrhosis: the caudate to right lobe ratio, the posterior right hepatic notch, and the expanded gallbladder fossa. *Current health sciences journal, 35*(1), 16.
4. Cheemerla, S., & Balakrishnan, M. (2021). Global epidemiology of chronic liver disease. *Clinical liver disease, 17*(5), 365-370.
5. Choi, J. H., Jun, D. W., Lee, H. H., Song, M. H., Kim, S. H., Jo, Y. J., & Lee, W. M. (2008). Giant hyperplasia of the caudate lobe in a patient with liver cirrhosis: case report and literature review. *Gut and Liver, 2*(3), 205.
6. Contractor, J. B., Patel, V. D., & Vaniya, V. H. (2021). Harbin's index: Morphological evaluation of caudate-to-right lobe ratio in human cadaveric liver. *Journal of The Anatomical Society of India, 70*(3), 168-172.
7. de Hemptinne, A., Husson, T., & Azoulay, D. (2024). Giant caudate lobe in secondary biliary cirrhosis. *Journal of Gastrointestinal Surgery, 28*(6), 1000-1002.
8. Gardner, M. T., Cawich, S. O., Zheng, Y., Shetty, R., Gardner, D. E., Naraynsingh, V., & Pearce, N. W. (2019). Morphology of the caudate lobe of the liver in a Caribbean population. *Italian Journal of Anatomy and Embryology, 124*(3), 364-376.
9. Harbin, W. P., Robert, N. J., & Ferrucci Jr, J. T. (1980). Diagnosis of cirrhosis based on regional changes in hepatic morphology: a radiological and pathological analysis. *Radiology, 135*(2), 273-283.
10. Ilione, T., Ohagwu, C. C., & Ogolodom, M. P. (2019). 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, 13*(5), 1-7.
11. Iwanaga, J., Singh, V., Takeda, S., Ogeng'o, J., Kim, H. J., Moryś, J., ... & Tubbs, R. S. (2022). Standardized statement for the ethical use of human cadaveric tissues in anatomy research papers: Recommendations from anatomical journal editors-in-chief. *Clinical Anatomy, 35*(4), 526-528.
12. Kumon, M. (1985). Anatomy of the caudate lobe with special reference to the portal vein and bile duct. *Kanzo, 26*, 1193-1199.
13. Oguz, N. K., & Gunduz, D. (2023). Assessment of the morphology and morphometry of the caudate lobe of the liver using computed tomography. *European Review for Medical & Pharmacological Sciences, 27*(8).
14. Roy, T., & Basu, R. (2022). Morphology and Morphometric Analysis of the Caudate Lobe of Human Liver in Eastern India-A Cross-sectional Cadaveric Study.
15. Sagoo, M. G., Aland, R. C., & Gosden, E. (2018). Morphology and morphometry of the caudate lobe of the liver in two populations. *Anatomical science international, 93*(1), 48-57.
16. Schuppan, D., & Afdhal, N. H. (2008). Liver cirrhosis. *The Lancet, 371*(9615), 838-851.
17. Syamala, G., Veernala, P., & Shravya, E. C. (2019). A Descriptive Study of Morphology of Caudate Lobe of Liver in Adult Human Cadavers in Siddhartha Medical College, Vijayawada. *IOSR-JDMS, 18*(8), 48-53.
18. Van Minh, T., Galizia, G., & Lieto, E. (1992, January). Anatomy of the caudate lobe of the liver. New aspects and surgical applications. In *Annales de Chirurgie* (Vol. 46, No. 4, pp. 309-17).
19. Watanabe, S., Kimura, Y., Nishioka, M., Ohkawa, M., Kozeki, M., Yano, M., & Hashimoto, N. (1999). Assessment of hepatic functional reserve in cirrhotic patients by computed tomography of the caudate lobe. *Digestive diseases and sciences, 44*(12), 2554-2563.