Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 5 No. 9 (2024): September 2024 Issue
https://doi.org/10.51168/sjhrafrica.v5i9.1379
Original Article

ANALYSIS OF SPLENIC NOTCHES IN HUMAN CADAVERS AND ITS CLINICAL RAMIFICATIONS: A CROSS-SECTIONAL STUDY

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Abstract

Introduction

Understanding the exterior shape of the spleen anatomically is crucial for both radiological and surgical diagnosis. The superior border splenic notches are a defining trait of the spleen, yet they hardly ever go into detail to be regarded as fissures or divide the spleen into several lobes. There aren't many splenic fissures cadaveric reports to date. To determine the frequency and clinical importance of splenic notches, lobation, and fissures, this study looked at the morphological structure and anatomy of spleens removed from cadavers.

Methods

This cross-sectional study was conducted at the Department of Anatomy, Medical College and Hospital, Keonjhar, over one year. A total of 100 spleens were obtained from cadavers, dissected, and preserved in 10% formalin. The spleens were analyzed for notches, lobation, and fissures, and their morphological characteristics were documented.

Results

Of the 100 spleens studied, 40% showed notches on the superior border, while 10% exhibited notches on the inferior border. The remaining 50% had no notches on either border. Fissures were observed in 10% of the spleens. Among these, six (6%) had incomplete fissures, while four (4%) had complete fissures that divided the spleen into two lobes. The complete fissures resulted in bilobed spleens, with distinct hila for each lobe. In cases where fissures were present, they varied in depth and width, with incomplete fissures reaching depths of 0.5-1 cm without leading to lobation.

Conclusion

The results of this investigation shed important light on the morphology and frequency of bilobed spleens and splenic fissures. Different from other recognized splenic defects, a bilobed spleen is an uncommon congenital abnormality. When performing conservatory splenectomy procedures, surgeons might use the splenic fissures in bilobed spleens as guidance.

Recommendation

To lower the risk of surgical complications, we recommend a procedure of partial splenectomy in less severe cases.

Keywords: *Spleen, Abnormalities, Congenital Abnormalities, Anatomic Variation,*
Submitted: 2024-09-08 Accepted: 2024-09-30

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Introduction

The largest organ of the lymphatic system is the spleen, situated in the upper left region of the abdomen [1, 2]. This organ has a wedge-like shape and features three surfaces— internal and external surfaces—and three edges—the upper, lower, and middle edges. In adults, the spleen typically weighs 150 grams and has dimensions of 3 x 12 x 7 centimeters [1,2]. There are instances where the superior border develops between two and four notches during embryonic development[1-4]. On the other hand, the inferior or intermediate boundaries rarely have notches [2].

Palpating an enlarged spleen is frequently guided by splenic notches located along the superior border [3]. The notches, however, divide the spleen into two or more lobes in certain variant spleens, extending as fissures on both the visceral sides and costal sides [5]. Further complicating the process of establishing the boundaries between the spleen and other tissues like the stomach and kidneys is the existence of notches along the inferior border. Radiological studies may mistakenly identify fluid

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accumulation in splenic fissures as lacerations because of their depth [6].

The spleen is frequently involved in blunt abdominal trauma, which can result in intraabdominal problems such as hemorrhage as well as peritonitis. While a total removal of the spleen is the preferred treatment for spleen damage, current recommendations suggest a partial removal of the spleen in less severe cases to decrease the risk of complications after surgery [2]. This means that radiologists and surgeons need to be well aware of the spleen's anatomy, including its lobes, segments, ligaments, and splenic artery, as well as how it fits about other surrounding tissues [7]. Nevertheless, there aren't many published cadaveric studies that describe bilobed spleens and splenic fissures. To assess and analyze the clinical significance of grooves, splenic indentations, and lobes in spleens removed from deceased individuals over a year, the present study was conducted.

Methods

Study design

A cross-sectional study.

Study Setting

The specimens used in this study were gathered over the course of October 2023 to September 2024 at the Medical College and Hospital in Keonjhar's Department of Anatomy.

Study Population

Throughout the investigation, 100 cadavers with unclear medical histories had their spleens removed. During a routine dissection of the abdominal cavity, the spleens were extracted by meticulously severing the splenic vessels near the hilum and separating the organ from the peritoneal lining. Once removed, the spleens were preserved in a 10% formalin solution.

Statistical Analysis

To check for lobation, fissures, and splenic notches, each spleen was closely examined. Photographs of spleens exhibiting irregular cracks, notches, and many lobes were taken. Making use of a Microsoft Corp., Redmond, Washington, USA, Excel spreadsheet, Version 2016, the data were tallied and then further analyzed. The results were then contrasted with those from earlier research projects that had been published in the literature.

Ethical considerations

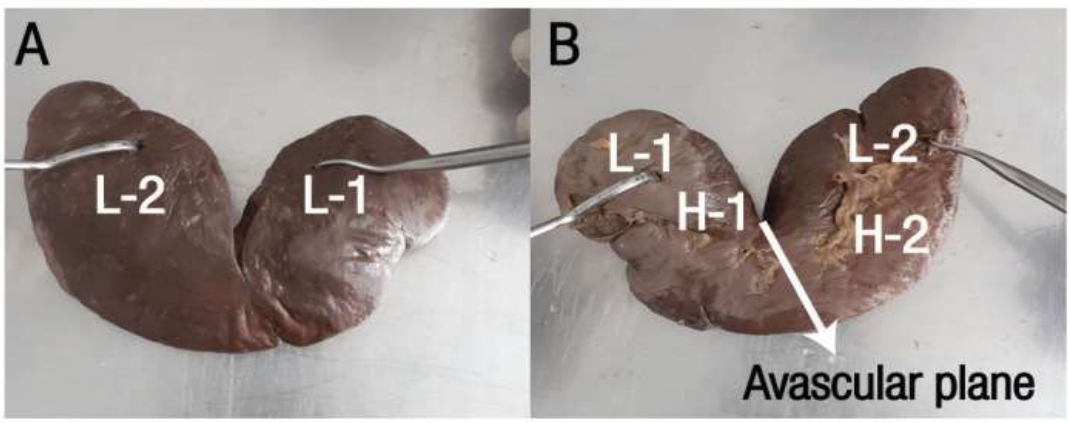
The Ethics Committee gave its ethical approval for this investigation. Every cadaver used in the study was an unclaimed body that was sent to a government tertiary care hospital for educational and scientific purposes.

Results

Fifty spleens (50%) showed no notches at either border, whereas 40 (40%) and 10 (10%) of the 100 spleens exhibited notches at the superior and inferior borders, respectively. Ten spleens (10%) had fissures visible. Among those with splenic notches, there were 2-4 at the cephalic border and 1-2 at the caudal border. The completeness or incompleteness of fissures was determined by their depth and width. In four (4%) and six (6%) of the spleens, full and incomplete fissures were seen.

A bilobed spleen was observed at the lower edge of the superior surface; moreover, each lobe possessed a distinct hilum, as illustrated on the internal surface (Figures 1A and 1B). One of the grooves that divided the spleen into two lobes, visible solely on the internal surface, extended as a fissure from the upper to the lower border of the superior surface. On the superior surface of the other spleen, two cuts were present at the inferior border, with one extending as a fissure from the border beneath the hilum.

Figure 1- Images of a cadaveric spleen's (A) superior and (B) internal surfaces showing a full fissure that splits the organ into two lobes (L = lobe; H = hilum).



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On the superior as well as internal surfaces of the other three spleens, incomplete fissures measuring about 3.4 cm in dimensions were apparent. These fissures extended to a depth of roughly 0.5–1 cm in the absence of lobation. For comparison's sake, a typical spleen without any notch or fissure at either border is displayed.

Discussion

In humans, the spleen starts to form during the fourth week of gestation as a result of mesenchymal condensation in the dorsal mesogastrium of the lesser sac. These mesenchymal cells later differentiate to create lobules that ultimately merge to develop the spleen, which is a lymphatic organ [3, 4]. Multiple lobules unite to create indentations along the upper edge of the spleen [8, 9]. Most of the lobules that normally make up the fetal spleen disappear before birth, but some may stay and develop into an auxiliary spleen that is located close to the hilum. A common congenital splenic anomaly is auxiliary spleens, which are infrequently detected on the upper segment of the kidney and misdiagnosed as a tumor or renal mass [10].

Splenomegaly can be a presenting feature of several immunological, viral, and hematological illnesses. When the spleen is palpated, notches on its superior edge clinically suggest an enlarged spleen [3]. In the left upper quadrant, splenic indentations aid in the radiological distinction of the spleen from other organs [10]. The upper edge of the spleen in humans typically features four to five notches; a greater number of notches suggests the spleen's embryonic persistence [1,3]. However, some abnormal spleens may have as many as seven notches along their upper border [11].

In this study, the highest number of notches observed on the upper border was four. Previous research indicates variability in the percentage of spleens exhibiting notches along the upper edge, ranging from 50% to 98% [2,5,8,10]. Still, the current investigation found a significantly lower prevalence of splenic notches (40%). According to a study, during splenic surgical procedures, extra caution should be used to ligate the many arteries that enter the organ through the splenic notches [2].

It is extremely uncommon to have notches along the inferior border; prior research has indicated that this characteristic occurs in about 4-8% of cases [8,12]. In the present study, ten percent (10%) of the spleens exhibited incisions on their lower edge; notably, in one instance, two notches were observed, one of which extended as a fissure to the hilum, dividing the spleen into two lobes on the internal surface, sharing a single hilum. The finding that 10% of the spleens showed incisions on the lower edge, with one case where a fissure extended to the hilum and divided the spleen into two lobes, highlights notable anatomical variation. This location, with two lobes sharing a single hilum, could complicate surgical procedures like splenectomy, requiring careful handling of the altered blood supply. Clinically, these variations may also lead to diagnostic challenges, as fissures could be misinterpreted as lacerations in radiological imaging. This atypical fissure may result from pressure from adjacent organs or a developmental anomaly that occurred during the merging of the splenic lobules [8]. In cases of abdominal trauma, these fissures may resemble a splenic tear or laceration, potentially creating diagnostic challenges. In the current investigation, 50% of the remaining spleens showed no obvious notches on either border. From an embryological standpoint, the lack of notches indicates that the splenic lobules have completely fused throughout fetal development, but this has no clinical significance [4].

Splenic fissures are 2-3 centimeter-deep grooves on the spleen's diaphragmatic and visceral surfaces. Deep cracks on the diaphragmatic surface are hardly frequently seen [8, 13]. In the current study, only one spleen exhibited a complete fissure that divided it into two lobes, extending from the upper to the lower edge of the superior surface. The finding of a single spleen with a complete fissure dividing it into two lobes is a rare anatomical variation. This fissure, extending from the upper to the lower edge, could affect surgical approaches like partial splenectomy due to the lobes' potentially independent structures. It may also be mistaken for a laceration in radiological imaging, highlighting the need for awareness of such variations in clinical practice. Similarly, a study reported that this feature was observed in just 2% of cases [8]. Another study described a case involving multiple hila and a bilobed spleen separated by a single fissure on the costal/superior surface [14]. A complete fissure that divides the spleen into two lobes appears to be relatively rare [15].

The two methods most commonly used for imaging the spleen are computed tomography (CT) and ultrasound, both of which typically exhibit a uniform pattern [16]. However, bilobed spleens may appear on arterial-phase CT scans as a mottled heterogeneous enhancement pattern, resembling a zebra pattern, due to varying blood flow rates through the sinuses of the red pulp [17]. This is an important discovery that can aid in differentiating between bilobed and normal spleens. Additionally, it's important to distinguish bilobed spleens from a broad range of other congenital splenic malformations, including splenunculi, and auxiliary spleens, besides other nearby solid masses.

(CT) and ultrasound, both of which generally present a consistent pattern [16]. However, bilobed spleens may be seen on arterial-phase CT scans as a mottled heterogeneous enhancement pattern, akin to a zebra pattern, owing to differing blood flow rates through the sinuses of the red pulp [17].

There have long been concerns about the spleen's segmentation because of the presence of splenic notches. The human spleen is separated into segments by fibrous septa, just like the spleens of dogs, cats, and horses, according to a study done in 1870 [18]. The spleen is made up of separate segments, each of which has its venous drainage system and specialized artery supply. This was

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demonstrated in 1956 when radiopaque media was administered by Braithwaite and Adams into the spleens or portal venous system tributaries of rats [19]. Currently, there is debate on the precise number of spleen segments in humans, despite numerous studies on the subject (Table 1) [20-24].

Table 1- Overview of the literature on studies evaluating the subject of spleen segmentation

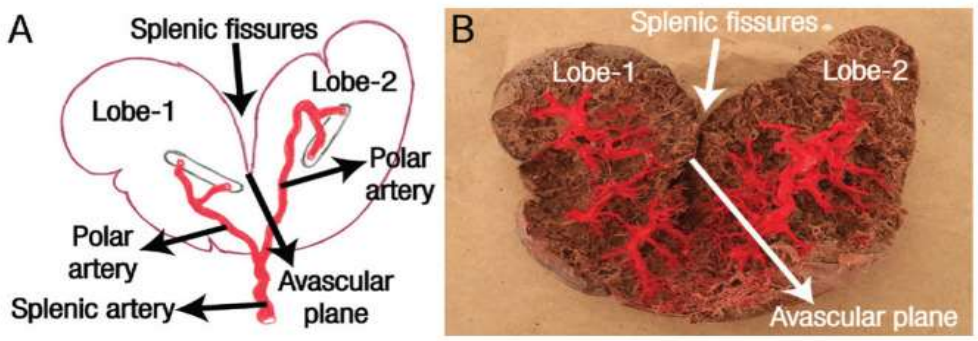
Author and year of publication	Number of segments
Gutierrez Cubillos (1969)	2-4
Gupta et al. (1976)	2-4
Mikhail et al.(1979)	5
Voboril (1982)	6
Redmond et al. (1989)	2
Present study (2020)	2

Studies by groups such as Gupta et al. besides others have revealed the presence of 2-4 segments, but a study asserted the existence of up to five distinct lobes [20–22]. Voboril discovered, on average, six different segments, but as many as ten [23]. Utilizing a combination of radiography, macroscopic dissection, and casting techniques, Redmond and associates reported that the spleen was divided into three sections: one at each pole and one in the central area [24].

Understanding the anatomy of the splenic vasculature is essential for spleen procedures. Splenic arteries typically do not anastomose, leaving avascular planes dividing several vascular segments [25]. The first step in splenic lobectomies or segmentectomies is to ligate the vessels in the damaged lobe or segment [26, 27]. The bilobed spleen in the present study featured two equal-sized, similarly-shaped lobes that resulted from a single fissure.

Together with the left gastric and hepatic arteries, the splenic artery typically originates from the celiac trunk [1]. Conversely, the authors suggest that bilobed spleens possess a single fissure that signifies the avascular plane of separation, along with two polar branches that arise from the splenic artery (Figure 2). During subtotal splenectomies, blood loss can be reduced by using these avascular planes between segments [28]. Additionally, during partial splenectomies, surgeons may utilize the splenic fissures in bilobed spleens as a reference when ligating an artery.

Figure-2- A: Distinct branches of the polar artery and hila in a bilobed spleen. B: Diagram illustrating the avascular plane that divides the two lobes of a bilobed spleen.



Generalizability

The generalizability of this study's findings may be limited due to its sample size and the use of cadavers with unknown medical histories from a single institution. While the study provides valuable insights into splenic anatomical variations, such as fissures and lobation, these variations might differ across diverse populations and settings. Additionally, the absence of clinical background information limits the ability to correlate anatomical findings with underlying health conditions or demographics. Therefore, further research involving larger, more diverse populations is necessary to fully understand the prevalence and clinical implications of these splenic variations.

Conclusion

Understanding the overall shape and structure of the abdominal organs, including the kidneys, pancreas, liver, and spleen, is crucial in cases of blunt abdominal trauma. This study reports on fissures, notches, and lobation observed in spleens removed from cadavers over one year. There were significant variations in the number of grooves and fissures on the superior and internal surfaces, which extended to different depths and occasionally separated the spleen into two distinct lobes. Bilobed spleens are among the rarest forms of congenital splenic anomalies. These findings are valuable for both conservative splenectomies and for distinguishing splenic variants from other organ abnormalities during abdominal imaging.

Limitation

The only limitation of this study is that less number of participants were included.

Recommendation

In less severe situations, we advise a partial splenectomy to reduce the possibility of surgical complications.

Acknowledgment

We are thankful to the patients; without them, the study could not have been done. We are thankful to the supporting staff of our hospital who were involved in the patient care of the study group.

Conflict of Interest

Conflicts of interest are not addressed by the writers.

Source of Funding

This study was not funded in any way.

References

1. Standring S, editor. Gray's Anatomy: The anatomical basis of clinical practice. 39th ed. London, UK: Churchill Livingstone; 2005. pp. 1239-44.
2. Skandalakis JE. Skandalaki's Surgical Anatomy: The embryologic and anatomic basis of modern surgery. Nicosia, Cyprus: Broken Hill Publishers Ltd.; 2004. pp. 1231-77.
3. Moore KL, Persaud TV. The Developing Human: Clinically oriented embryology. 6th ed. Philadelphia, Pennsylvania, USA: Saunders; 1998. pp. 271-302.
4. Larsen WJ, editor. Human Embryology.2nd ed. Philadelphia, Pennsylvania, USA: Saunders; 1997. pp. 229-59.
5. Nayak BS, Somayaji SN, Soumya KV. A study on the variations of size, shape, and external features of the spleen in the south Indian population. Int J Morphol. 2011;29:675-77. https://doi.org/10.4067/S0717-95022011000300001
6. Dodds WJ, Taylor AJ, Erickson SJ, Stewart ET, Lawson TL. Radiologic imaging of splenic anomalies. AJR Am J Roentgenol. 1990;155:805-10. https://doi.org/10.2214/ajr.155.4.2119113
7. Zarzaur BL, Rozycki GS. An update on nonoperative management of the spleen in adults. Trauma Surg Acute Care Open. 2017;2:e000075. https://doi.org/10.1136/tsaco-2017-000075
8. Das S, Abd Latiff A, Suhaimi FH, Ghazali H, Othman F. Anomalous splenic notches: A cadaveric study with clinical importance. Bratisl Lek Listy. 2008;109:513-16.
9. Gayer G, Hertz M, Strauss S, Zissin R. Congenital anomalies of the spleen. Semin Ultrasound CT MR. 2006;27:358-69. https://doi.org/10.1053/j.sult.2006.06.002
10. Ungör B, Malas MA, Sulak O, Albay S. Development of spleen during the fetal period. Surg Radiol Anat. 2007;29:543-50. doi: 10.1007/s00276-007-0240-2. https://doi.org/10.1007/s00276-007-0240-2
11. Gandhi KR, Chavan SK, Oommen SA. Spleen with multiple notches: A rare anatomical variant with its clinical significance. Int J Stud Res. 2013;3:24-5. https://doi.org/10.4103/2230-7095.113829
12. Parsons FG. Notches and fissures of the spleen. J Anat Physiol. 1901;35:416-27.
13. Nayak SB, Kumar V, Kumar N, Jetti R. Unusual fissure on the diaphragmatic surface of the spleen: A case report. Int J Anat Var. 2012;5:96-8.
14. Nayak SB, Shetty P, Deepthinath R, Sirasanagandla SR, Shetty SD. A lobulated spleen with multiple fissures and hila. J Clin Diagn Res. 2014;8:AD01-2. https://doi.org/10.7860/JCDR/2014/8996.4774
15. Yildiz AE, Ariyurek MO, Karcaaltincaba M. Splenic anomalies of shape, size, and location:

Pictorial essay. ScientificWorldJournal.2013;2013 https://doi.org/10.1155/2013/321810
16. Vancauwenberghe T, Snoeckx A, Vanbeckevoort D, Dymarkowski S, Vanhoenacker FM. Imaging of the spleen: What the clinician needs to know. Singapore Med J. 2015;56:133-44. https://doi.org/10.11622/smedj.2015040
17. Ali HM. Bilobed spleen: An extremely rare imaging finding. BJR Case Rep. 2017;3:20170021. https://doi.org/10.1259/bjrcr.20170021
18. Kyber E. Über die Milz des Menschen und einiger Säugetiere [Concerning the spleen of humans and some other mammals] Arch Mikrosk Anat. 1870;6:540-80. https://doi.org/10.1007/BF02955992
19. Braithwaite JL, Adams DJ. Vascular compartments in the rat spleen. Nature. 1956;178:1178-9. https://doi.org/10.1038/1781178a0
20. Gutierrez Cubillos C. Segmentación esplénica [Splenic segmentation] Rev Esp Enferm Apar Dig. 1969;29:341-50.
21. Gupta CD, Gupta SC, Arora AK, Singh PJ. Vascular segments in the human spleen. J Anat. 1976;121:613-16.
22. Mikhail Y, Kamel R, Nawar NN, Rafla MF. Observations on the mode of termination and parenchymal distribution of the splenic artery with evidence of splenic lobation and segmentation. J Anat. 1979;128:253-8.
23. Voboril Z. On the question of segmentation of the human spleen. Folia Morphol (Praha) 1982;30:295-314.
24. Redmond HP, Redmond JM, Rooney BP, Duignan JP, Bouchier-Hayes DJ. Surgical anatomy of the human spleen. Br J Surg. 1989;76:198-201. https://doi.org/10.1002/bjs.1800760230
25. García-Porrero JA, Lemes A. Arterial segmentation and subsegmentation in the human spleen. Acta Anat (Basel) 1988;131:276-83. https://doi.org/10.1159/000146529
26. Liu DL, Xia S, Xu W, Ye Q, Gao Y, Qian J. Anatomy of the vasculature of 850 spleen specimens and its application in partial splenectomy. Surgery. 1996;119:27-33. https://doi.org/10.1016/S0039-6060(96)80209-1
27. Vanhoenacker FM, Op de Beeck B, De Schepper AM, Salgado R, Snoeckx A, Parizel PM. Vascular disease of the spleen. Semin Ultrasound CT MR. 2007;28:35-51. https://doi.org/10.1053/j.sult.2006.10.006
28. Uy PPD, Francisco DM, Trivedi A, O'Loughlin M, Wu GY. Vascular diseases of the spleen: A review. J Clin Transl Hepatol. 2017;5:152-64. https://doi.org/10.14218/JCTH.2016.00062

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