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Original Research Paper

Anatomy

MORPHOLOGICAL ANALYSIS OF SPLENIC NOTCHES AND THEIR CLINICAL IMPLICATIONS IN CENTRAL GUJARAT.

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ABSTRACT

Background: While the spleen typically exhibits lobulation during fetal development, the persistence of these prenatal features leads to the formation of distinct notches on adult splenic borders. A precise understanding of these morphological variations is essential for surgeons performing splenectomies and radiologists interpreting abdominal imaging. **Objectives:** This study was designed to evaluate the morphological patterns of splenic notches within the Central Gujarat population and to examine their broader clinical implications. **Methods:** A descriptive anatomical study was performed using 27 formalin-fixed human spleens. Each specimen was precisely examined to record its overall shape, the presence and distribution of notches on both the superior and inferior borders, and the incidence of anomalous fissures. The resulting data were evaluated using descriptive statistics to establish the prevalence of these anatomical landmarks. **Results:** Morphological analysis revealed that the wedge shape was the most common (48.1%), followed by tetrahedral (29.6%), triangular (14.8%), and oval (7.4%) configurations. Superior border notches were present in 77.8% of the sample, while inferior border notches were identified in 55.6%. In most instances, a single notch was the predominant finding on either margin. Notably, anomalous fissures on the diaphragmatic surface were detected in over half the specimens (51.9%), whereas a total absence of notches across both borders occurred in only 14.8% of cases.

KEYWORDS : Spleen, Splenic Notch, Morphological Variation, Anatomical Landmarks, Clinical Anatomy.

INTRODUCTION

As the human body's largest lymphoid organ, the spleen occupies a critical position within the left hypochondrium. Historically described as having a shape ranging from a curved wedge to a tetrahedral configuration, its morphology is defined by a complex arrangement of borders, surfaces, and poles. In the average adult, the organ typically measures 12 cm in length and 7 cm in width, with a weight of approximately 150 grams. Its diaphragmatic surface remains smooth and convex, while the visceral surface is marked by the irregular impressions of the stomach, colon, and left kidney[1].

The development of the spleen during embryogenesis is a process of fusion; it arises from mesenchymal cells within the dorsal mesogastrium that form distinct lobules. While these lobules usually merge, the splenic notches—most commonly found along the superior border—persist as a structural record of this fetal origin. Although standard textbooks often treat these notches as a uniform feature, they are subject to significant diversity in form and frequency.

In a clinical setting, these variations are clinically significant. For the clinician, the splenic notch is a vital palpation landmark used to distinguish a displaced spleen from a renal mass[2]. In modern radiology, however, these same features can pose a challenge; deep fissures are occasionally mistaken for splenic fractures in trauma patients or misidentified as pathological lesions[9]. Despite this, there remains a notable gap in the literature regarding the specific morphological patterns prevalent in the Central Gujarat population. This study aims to address that gap, documenting these anatomical variations to provide more reliable diagnostic data for local practitioners[11].

MATERIALS AND METHODS

This descriptive, cross-sectional morphological study was conducted in the Department of Anatomy. The study aimed to evaluate the anatomical variations of splenic notches and fissures in human cadaveric specimens. Specimen Selection A total of 27 formalin-fixed human spleens were utilized for this investigation.

These specimens were obtained from adult cadavers during routine educational dissections. To ensure the integrity of the data, the following criteria were applied:

Inclusion Criteria: Spleens with intact morphology and well-preserved borders.

Exclusion Criteria: Specimens showing evidence of significant trauma, prior surgical intervention, gross pathological changes - advanced decomposition that obscured anatomical landmarks.

Data Collection and Procedure

The spleens were carefully cleaned of any adhering connective tissue, fat, and peritoneal reflections to clearly expose the borders and surfaces. Each specimen was systematically examined for the following morphological parameters:

1. Splenic Shape: Categorized into types such as wedge-shaped, tetrahedral, oval, or triangular.
2. Notch Distribution: The presence, number, and location of notches were recorded for the superior and inferior border.
3. Anomalous Fissures: Any deep indentations on the diaphragmatic were documented as anomalous fissures.

Statistical Analysis

The collected data were entered into a spreadsheet (Microsoft Excel) and analyzed using descriptive statistics. The frequency and percentage of each morphological variation were calculated to establish the prevalence of different notch

patterns within the studied population.

RESULTS

The macroscopic evaluation of the 27 cadaveric splenic specimens revealed notable diversity in their physical form. The wedge-shaped configuration was the most prevalent, identified in 13 cases (48.1%) (Fig. 3), followed by the tetrahedral shape in 8 specimens (29.6%) (Fig. 1). Triangular and oval morphologies were less frequent, representing 14.8% and 7.4% of the sample, respectively, as detailed in Table 1.

Distribution of Splenic Notches The analysis of splenic margins showed a higher incidence of notching on the superior border, appearing in 21 specimens (77.8%) (Fig. 2), compared to 15 specimens (55.6%) where notches were identified on the inferior border (Fig. 6).

A simultaneous occurrence of notches on both the superior and inferior margins was noted in 11 cases (40.7%) (Fig. 4). Conversely, a complete absence of notches across both borders was observed in only 4 specimens (14.8%). Regarding the diaphragmatic surface, anomalous fissures were identified in 14 specimens (51.9%), suggesting a high prevalence of persistent surface lobulation in this study group (Fig. 5).

Quantification of Notches per Border The degree of serration and the specific count of notches varied significantly across the specimens. The detailed quantification for both the superior and inferior margins is summarized in Table 2.

- Superior Border: The presence of a single notch was the most common finding (37%). Notably, two specimens (7.4%) displayed highly lobulated superior margins with more than four notches.
- Inferior Border: Notches were absent in 40.7% of the cases; where present, a single notch was the most frequent observation (37%).

The quantitative analysis (Table 3) highlights the significant variability between the two margins. While the superior border showed a higher number of Notches—with 77.7% of spleens possessing at least one notch—the inferior border remained smoother in a larger proportion of the sample (40.7% absence). The presence of multiple notches on the superior border remains a critical diagnostic feature for clinical identification.

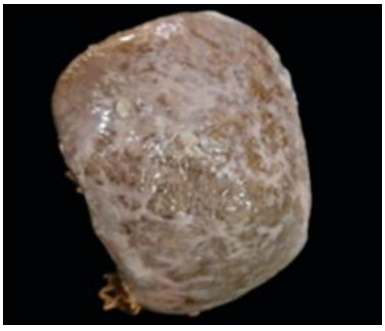

Figure 1 Tetrahedral Shape of Spleen

Figure 2 Notches in Superior Border [2 in Number]

Figure 3 Wedge Shape of Spleen

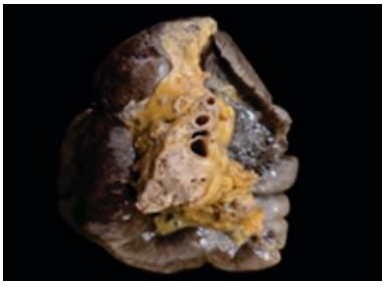

Figure 4 Notches in both Superior[5] and Inferior Border[2]

Figure 5 Accessory Fissure in Diaphragmatic Surface

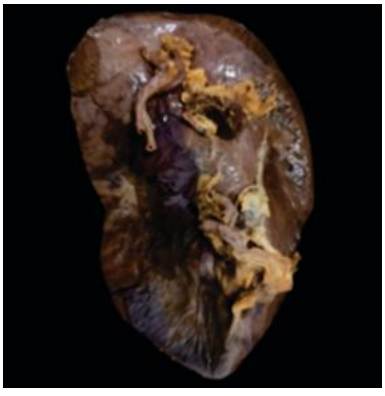

Figure 6 Notches in the Inferior Border[1 in number

Table 1: Distribution of Splenic Shapes (n=27)

Morphological Shape	Frequency (n)	Percentage (%)
Wedge-shaped	13	48.1%
Tetrahedral	8	29.6%
Triangular	4	14.8%
Oval	2	7.4%

Table 2: General Distribution of Splenic Notches and Fissures (n=27)

Parameter	Frequency (n)	Percentage (%)
Notches on Superior Border	21	77.8%
Notches on Inferior Border	15	55.6%
Notches on Both Borders	11	40.7%

Absence of Notches (Both Borders)	4	14.8%
Anomalous Fissures (Diaphragmatic Surface)	14	51.9%

Table 3: Distribution and Percentage of Notches on Superior and Inferior Borders

Border Type	Number of Notches	Number of Spleens (n=27)	Percentage (%)
Superior Border	0	6	22.2%
	1	10	37.0%
	2	4	14.8%
	3	4	14.8%
	4	1	3.7%
	> 4	2	7.4%
Inferior Border	0	11	40.7%
	1	10	37.0%
	2	3	11.1%
	3	1	3.7%
	4	1	3.7%
	> 4	0	0%

DISCUSSION

The structural variability of the spleen is a direct consequence of its complex development within the dorsal mesogastrium. Our data shows a predominance of wedge-shaped (48.1%) and tetrahedral (29.6%) specimens, a distribution pattern that align closely with the findings of Chaware et al[6]. Such morphological data is vital for diagnostic accuracy, helping radiologists differentiate benign anatomical shapes from potential tumors.

The persistence of splenic notches serves as a physiological record of fetal lobulation[5]. While our data confirms the traditional view that these notches favor the superior border (77.8%), the 55.6% prevalence we found on the inferior border represents a significant variation from the lower rates reported by Das et al. and Sivanageswara Rao et al[13, 4, 1]. This discrepancy highlights the importance of population-specific anatomical studies. Furthermore, the "serrated" appearance found in 7.4% of our samples—where more than four notches were present—poses a genuine diagnostic challenge. As noted by Radu et al., such deep indentations can be mistaken for traumatic fractures in patients with blunt abdominal injuries[10].

We also identified diaphragmatic fissures in over half (51.9%) of our specimens. These deep lobulations, which Skandalakis et al. attribute to incomplete mesenchymal bridging, can mimic the appearance of infarcts or secondary malignancies on cross-sectional imaging[5,7]. Clinically, however, the notch remains an indispensable tool for the bedside physician; it is the hallmark that separates a displaced or enlarged spleen from a renal tumor during manual palpation[2].

Ultimately, the high frequency of these variations in our Central Gujarat sample suggests that clinicians must be vigilant. A thorough understanding of these fissures and notches is necessary to prevent diagnostic errors and to ensure safety during operative maneuvers such as splenic artery ligation or specialized resections[8].

The following table provides a comparison between the findings of the current study (n=27) and established trends in anatomical literature, highlighting the regional variations observed.

Table 4: Comparative Analysis of Splenic Findings

Parameter	Present Study (n=27)	Literature Trend
Most Common Shape	Wedge-shaped (48.1%)	Wedge-shape is commonly reported as the dominant morphology (Chaware et al6)
Superior Border Notches	77.8% (n=21)	Generally ranges between 70%–80% in most cadaveric studies (Das et al3, Khosla et al9)
Inferior Border Notches	55.6% (n=15)	Reported prevalence is usually much lower, between 2%–15% (Das et al3, Sivanageswara Rao et al4)
Anomalous Fissures	51.9% (n=14)	Frequently present but often underreported in standard textbooks (Radu et al10, Skandalakis et al5)
Absence of Notches	14.8% (n=4)	Aligns with findings of smooth splenic borders in a minority of the population (Nayak & Belsare 11)

CONCLUSION

This study confirms that the morphology of the spleen is highly variable in the central Gujarat population. The wedge-shaped configuration is the most dominant morphological type. A significant finding of this study is the high prevalence of notches on both the superior and inferior borders, along with a high frequency of anomalous fissures on the diaphragmatic surface.

Such variations are not merely anatomical diversities but have profound clinical implications. A precise understanding of these notches and fissures is indispensable for radiologists to avoid misdiagnosing them as splenic trauma or lesions, and for surgeons during procedures such as partial splenectomy. We recommend that these morphological variations be emphasized during routine anatomical dissections and clinical training to enhance diagnostic accuracy.

Limitation

Despite the detailed morphological analysis provided, the small sample size (n=27) limits the generalizability of our findings. Future research with a larger sample size is recommended to confirm the frequency of atypical splenic notches and fissures observed in this study.

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Conflict of Interest: None

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