

Morphological Variants of the Human Spleen: a Cadaveric Study

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ABSTRACT

Introduction: the goal of this investigation was to study the anatomical variability of human spleen in embalmed samples.

Material and Methods: this present investigation comprised 126 embalmed adult spleens, which existed at the anatomy department. The cadaveric spleens were macroscopically observed for the notches, fissures and various shapes. The dimensions of spleen like the breadth, length and thickness were also determined.

Results: it was observed that, 110 spleens (87.3%) revealed notches either in the superior or inferior border. The notches were commonly observed over the superior border (104 cases, 82.5%) and rarely observed in the inferior border and found only in 16 (12.7%) cases. The fissures were present in 18 spleens over the diaphragmatic surface (14.3%). The splenic length, breadth and thickness ranged from 9 to 27 cms, 6.1 to 15.7 cms and 1.3 to 6.1 cms respectively.

Conclusion: this study has provided information about the anatomical variations of spleen and its dimensions, which are enlightening to the operating surgeon. The knowledge is important during the procedures like laparotomy, laparoscopy and robotic platforms. The particulars are needed to radiologists while making a diagnosis and it will prevent the misinterpretation.

Keywords: Anatomic Variation; Spleen; Surgeries.

Introduction

Among clinicians and radiologists, the spleen is a neglected viscus unless it is enlarged, infarcted or ruptured.¹ However, the morphological awareness of the deviations of spleen is important to surgeons and radiologists. It was reported that the size of the spleen is surgically important and will dictate the type of surgical incision.² The diseases of spleen include traumatic rupture, neoplasia, hypersplenism, splenic cyst, etc., and splenectomy can be done on few occasions. The present tendency of the surgeons while managing the splenic diseases is to preserve the spleen.³ With this implication, the morphological details of the variant spleens are of significance.⁴ The morphological variants like fissures over the spleen can cause misinterpretation during the radiological examinations and laparoscopic surgeries.

The spleen can be a wedge shape or tetrahedral⁵ and it depends on the surrounding viscera.⁶ The spleen assumes its characteristic shape in the early fetal period, the fetal lobulations usually disappear later in the prenatal period. The characteristic notches are observed at the superior border of spleen.⁶ These notches indicate the multinodular origin of the spleen during its development.⁷ In the embryonic life, spleen is characterized by few nodules, which later join together to form the solitary spleen. Sometimes, the nodules may

develop independently into small small spleens. These small spleens are considered as the accessory spleens or splenunculi.⁶ Accessory spleens are morphological variants, which are joined by few splenic nodules of small size and these are separate from the main spleen. In an enlarged spleen, the notched superior border can be palpated. Michels⁸ reported that, the notched spleen is more vascular and is difficult to remove surgically. The characteristic notches over the superior border of spleen are due to inadequate fusion of the splenic nodules along the superior border during the development.⁶ Das *et al.*⁹ reported that it is imperative to distinguish the notches from an injury spot on the spleen. The goal of the current investigation was to study the morphological deviations of spleen in embalmed samples. The objectives were to study the splenic dimensions in these embalmed spleens.

Material and Methods

This research involved 126 adult embalmed spleens, which existed at the department of anatomy of our institutions. The genders of the specimens were not taken into consideration. The spleens which exhibited pathological changes were not included from the present investigation. This anatomical study has the approval of our institutional ethics committee. The spleens were macroscopically observed for the notches,

fissures and shapes. The splenic notches were checked both at the superior border and inferior border and counting of notches was done. Various shapes of spleen were also determined. The dimensions of spleen like thickness, breadth and lengths were determined with the help of measuring tape and digital Vernier caliper.

Results

The fissures on the diaphragmatic surface of spleen [Figure 1A] were observed in 18 spleens (14.3%). The present study observed that, 110 (87.3%) spleens revealed notches either in the superior or inferior border. The notches were commonly observed over the superior border (104 cases, 82.5%) and their amounts speckled from 1 to 6. The inferior border notches were rare [Figure 1B] and found only in 16 (12.7%) cases. In 6 (4.8%) spleens, the splenic notch was observed at the inferior border and not seen at the superior border. These notches were present neither in superior nor in inferior borders in 16 (12.7%) cases [Figure 1C]. The number of splenic notches in the superior border and their frequency is shown in Figure 2. The superior border had single notch in 43 cases (34.1%), double notches in 35 (27.8%), no notches in 22 (17.5%), three notches in 16 (12.7%), four notches in 5 (3.9%), five notches in 3 (2.4%) and six notches in 2 (1.6%) cases.

The length, breadth and thickness of the spleens ranged from 9 to 27 cms, 6.1 to 15.7 cms and 1.3 to 6.1 cms respectively. The average splenic length, thickness and width in this anatomical research were 13.1 cms, 9.7 cms and 3.3 cms correspondingly. Table 1 represents the range of frequency distribution of the different splenic sizes in the present investigation.

Table 1. range of frequency distribution of dimensions of spleen in the present study (n = 126)

Dimension	Frequency
length	
9-15 cms	56 (44.4%)
15.1-21 cms	55 (43.6%)
21.1-27 cms	15 (12%)
Width	
6.1-9 cms	76 (60.3%)
9.1-12 cms	42 (33.3%)
12.1-15.7 cms	8 (6.4%)
Thickness	
1.3-2 cms	50 (39.7%)
2.1-4 cms	62 (49.2%)
4.1-6.1 cms	14 (11.1%)



Figure 1. 1A- spleen having fissure (↓) over the diaphragmatic surface (14.3%); 1B- spleen showing notches (↓↓) over the inferior border (12.7%); 1C- spleen with absence of notches (12.7%).

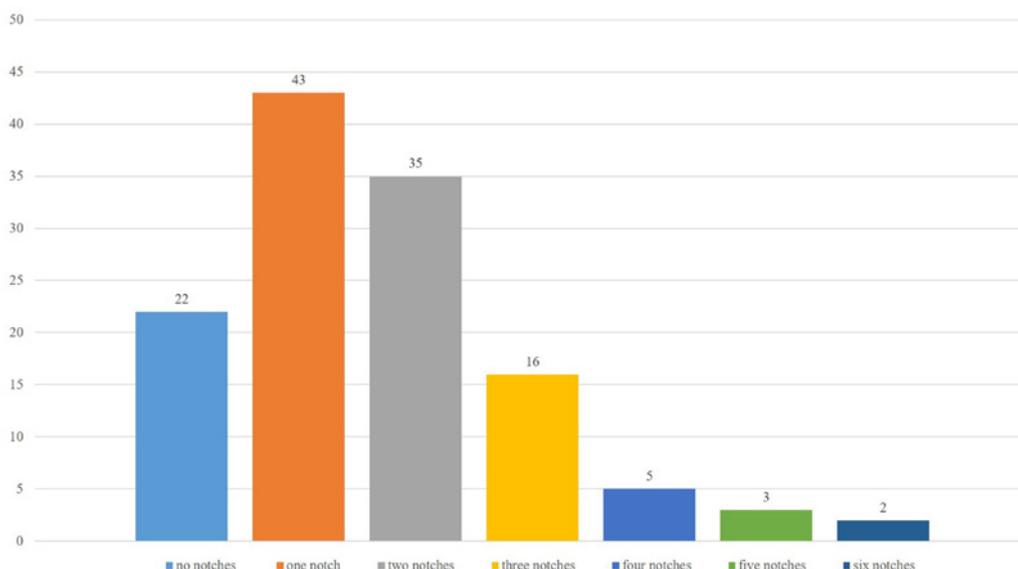


Figure 2. frequency of quantity of splenic notches over the superior border (n=126)

The spleen was wedge shaped in 49 (38.9%) cases, tetrahedral shaped in 25 (19.7%), triangular in 12 (9.5%), liver shaped in 4 (3.2%), oval shaped in 18 (14.3%), round shape in 6 (4.8%), disc shape in 2 (1.6%), kidney shaped in 2 (1.6%), 's' shaped in 1 (0.8%), quadrilateral shaped in 1 (0.8%), heart shaped in 3 (2.4%), spherical shaped in 1 (0.8%) and pear shaped in 2 (1.6%) specimens.

Discussion

Understanding of the anatomic variations of spleen is of necessary significance to the clinician. It is especially important in a case of blunt abdominal trauma, which may necessitate an ultrasound examination and emergency exploration of the abdomen. During the per abdomen examination done routinely, the superior border of the spleen is always checked. The spleen is diagnosed to be enlarged if the clinician could palpate its notches. The prior knowledge of fissures and notches of spleen will help the radiologist during the reporting of the images. The details are informative to the anatomy professors during their medical teaching.³ Sometimes, the morphological variants are considered cosmetic and have no potential clinical significance; however, they have to be distinguished from splenic lacerations or ruptures due to the mechanical trauma.^{10, 11} This can avoid the misinterpretation and subsequent iatrogenic complications.

In 98% of the splenic specimens of Das *et al.*⁹ revealed 2 to 4 notches at the superior border. The notches were present at the inferior border of spleen in only 2% of specimens. Chaware *et al.*³ reported that the splenic notches can be seen either at the superior and inferior border. In 74.8% of their spleens, the superior border revealed the notches. In their study, the quantity of notches varied between 0 and 6, however 58.5% of the spleens had either 1 or 2 notches. This was observed in 58.5% of specimens. In the present anatomical investigation, the characteristic notches over the superior border of spleen were observed in 82.5% cases and their numbers varied from 1 to 6. Our study also observed variant notches at the inferior border in only 12.7% of specimens. In the present study, same number of 16 (12.7%) spleens were not having notches. The embryological basis of this absence of notches is that the fusion of all the splenic nodules during the development, both at the superior and inferior borders.

Earlier anatomical investigations, reported the frequency of superior border splenic notches from 70 to 98% cases.^{9, 12-14} In the present study from south Indian population, the superior border splenic notches were witnessed in 82.5% cases. This is similar frequency in comparison to the previous reports. In a study from Hussein *et al.*,¹⁵ from the north Indian specimens, the superior border splenic notches were observed in only 59.3% of cases. The study from Nayak *et al.*¹⁶ which is also from South Indian population observed the splenic notches over the superior border in only half of

their specimens and it is among the lowest frequency being reported so far. The present investigation has observed variant notches at the splenic inferior border in 16 (12.7%) cases. This is almost analogous to the results of Hussein *et al.*,¹⁵ of 12.5% cases.

The variant fissures over the diaphragmatic surface of spleen are because of inadequate blending of the splenic nodules during the development or they may be also due to the avulsion by the adjacent internal organs. Das *et al.*⁹ described the presence of fissure over the diaphragmatic surface of spleen in 1% of their cases. Smidt¹⁷ informed a large fissure over the spleen, which mimicked splenic hematoma. In this research, the splenic fissures were found in 18 spleens (14.3%). This is slightly high in comparison to the previous reports. Nayak *et al.*⁶ observed a semilunar shaped fissure over the spleen, which is not observed in any of our specimens. Shewale *et al.*⁴ stated a lobulated spleen and it was having 6 lobules. In the study from Hussein *et al.*,¹⁵ the lobulations were observed in 3 spleens (9.3%). In our spleen specimens, the lobulations were also not observed. The prevalence of accessory spleens in the literature ranges from 11 to 44%¹⁸ and 75% of them are located at the hilum.¹⁹ Chaware *et al.*³ observed the accessory spleens in 4.5% of their cases. In this study, the accessory spleens were not observed in any of the spleens. This is due to the limitation of the present study as our spleen specimens were removed from the cadaveric abdomens. There are chances that accessory spleens might have lost during the removal of spleens.

Michels⁸ reported that, among his specimens 44% were wedge shaped spleens, 42% were tetrahedral and 14% were triangular. Chaware *et al.*³ reported various shapes of the spleens. They observed wedge shaped spleens in 61.3% cases, tetrahedral spleens in 21.6% and triangular spleens in 12.6% specimens. Their spleens were oval and irregular shapes in 3.6% and 0.1% cases respectively. In the present study, several different shapes of the spleen were observed. Some of our spleens were pear shape, round shape, disc shape and kidney shapes which are being reported for the first time in the literature. Among our specimens, the most common shape was wedge shape (38.9%), which was followed by tetrahedral (19.7%) and oval (14.3%) shapes. The differences in the splenic shape morphology in our specimens are may be due to the racial variations. Nayak *et al.*¹⁶ observed a liver shaped spleen, which was having 2 lobes. In a study from Hussein *et al.*¹⁵ from the north Indian population, the liver shaped spleens were observed in 6.2% cases. In our specimens, which is from south Indian population, the liver shaped bifid spleens were observed in 3.2% of cases. This is higher than that of Nayak *et al.*¹⁶ and lesser than Hussein *et al.*¹⁵ finding.

It was reported that, on roentgenograms, the spleen measures about 50 mm in width and 140 mm in length.²⁰ In a study by Chaware *et al.*³ from the

anatomical specimens, the lengths of the spleens varied between 5 and 13 cms, averaging 9.66 cms. The breadth was ranging between 3.5 and 9.5 cms (average breadth, 6.22 cms). In our study, the splenic length ranged between 80 and 230 mms, width ranged between 56 and 160 mms. The average length and width in the present anatomical research were 131 mms and 97 mms correspondingly. The present study has observed a wider range of the measurements and the dimensions are higher compared to the previous reports. The limitation of the anatomical studies is that the specimens will be embalmed and stored in formalin container. There are chances of variability in the formalin concentration and other chemical

preservatives, which may cause variability in the dimensions of cadaveric specimens.

Conclusion

The present anatomical investigation has delivered evidence about the morphological variations of spleen and its dimensions, which are important to the operating surgeons. During the radiological examination, the presence of variant fissures on the spleen may cause misinterpretations and can be mistaken for the splenic lacerations, ruptures. The knowledge is important during the procedures like laparotomy, laparoscopy and robotic platforms.

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