

# Improving the clarity of how students understand and learn the gross borders and relations of the human spleen

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## INTRODUCTION

Henry Gray was the author of first edition of the 750-paged Gray's Anatomy, a book series which has surpassed all expectations and is 'probably the best-known medical textbook in the world' (p. 5), despite Mr Gray passed away at the young age of 34 years [1]. Gray's earlier work helped cement his academic respect, such as the "essay, nearly 350 pages, handwritten, on blue laid paper" (p. 23) on the spleen entitled 'On the structure and use of the human spleen' that won him the prestigious Astley Cooper prize of three hundred guineas and was published as a book [1]. The trustees of the famous surgeon Astley Cooper Will had acknowledged that the structure of the spleen was poorly understood then in 1853 [1]. The borders and the relation of the spleen remain confusingly presented to students from the anatomical knowledge in textbooks to this very day.

There are a number of glaring inconsistencies concerning the borders and relations of the spleen of humans in mainstream anatomy textbooks. The left kidney has been said to be related antero-medially [2], medially [3, 4], posterior-medially [5] and posteriorly [6, 7], inferior-medially and slightly posteriorly [8] and in

unspecified relation [9, 10] to the spleen. The diaphragm too is said to be in various positions and include being related laterally [11], posterior-laterally [12], posteriorly [2–4] and in an unspecified relation [5, 7, 9, 10, 13] to the spleen.

The consensus among the anatomical knowledge base is far better on how the stomach is related to the spleen. The stomach lies anteriorly [2–4, 6, 7], anterior-medially [8, 9] and anterior-superiorly [5], while not explicitly specified in other anatomical textbooks [10–13]. The best consensus is on describing the left colic flexure as being inferior to the spleen [3, 4, 6, 7, 9], although other positions have been offered like being anterior [2] and anterior-inferiorly [5]. A common feature on the sharp edge of the spleen are the splenic notches, usually two in number, and they are said to be either on the lateral end of the superior border [14], superior border [8, 9, 12], upper (superior) or anterior border [5], anterior-superior border [4, 10] or the anterior border [2, 6, 7, 13].

Various knowledge based professions have sought to have well demarcated body of knowledge that new entrants should have as a minimum, in order to give confidence to the public [15]. The National Policy Board of Educational Administration sought to "codify or catalogue a body of knowledge ... called a knowledge base" (p. 17) [15] that is standard, very objective and well defined. "A knowledge base is the core knowledge, or canon, that every member of the profession should know. A knowledge base standardizes the profession in that all of its members are certified to have mastered this canon. It also standardizes the training necessary to become a member of the profession in such a way that it does not matter in which institution a person receives his or her training" (p. 18) [15].

The appetite for 'an accurate knowledge of anatomy' [16] among medical students has culminated in the assembling of a standard anatomical knowledge base for medical students in different countries. The Education Committee of the Anatomical Society of Great Britain and Ireland assembled an anatomy curriculum for British medical students [17]. Likewise the Netherlands [18],

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Turkey [19] made standardized anatomy curricula, and so did USA by the Educational Affairs Committee of the American Association of Clinical Anatomists [20].

The aim of the current paper is to determine standard underlying anatomical descriptions that can be concisely used to teach students the borders and relations of the spleen in humans and will allow clinicians to more confidently locate the surface anatomical projection of the spleen during clinical examination.

## MATERIALS AND METHODS

The Grounded Methodology by Strauss and Corbin was used to find the underlying concepts that could be used to teach of the borders and relations of the spleen in humans [21]. Twenty-five anatomy textbooks that formed part of the personal library of the author were used [2–14, 22–33]. The text and diagrams of these books were used until data saturation was achieved and no new concepts or need to modify the concepts made during the grounded methodological procedure. Memo notes from most of the books were kept during the process of using grounded theory and included rough diagrams. The way textbooks were examined was not linear and frequently involved going through the entire set of books again to re-evaluate a particular concept or anatomical aspect. Most books were critically read at least five times each. Popular standard anatomical textbooks formed the bulk of the textbooks and were complimented by anatomical atlases and clinical examination books.

## RESULTS AND DISCUSSION

Three concepts emerged from the grounded theory: two problematic concepts and one solution concept. The two problematic concepts explained why there is underlying discord and disharmony among the descriptions of the borders and relations of the spleen: were the degree of glide of the spleen along the 10th rib and the inadequacy of standard anatomical planes in describing the borders and relations of the spleen. Although there is consensus that the most posterior and medial part of the spleen is 4 cm lateral from the tip of the T10 spine and the most anterior and lateral part of the spleen lies along the mid-axillary line, the relations of the spleen tell a different story. The relations imply that there are three main possible positions for the spleen: a posterior, a posterior-lateral and a laterally placed spleen (Figure 1). Each position alters the relations of the spleen and the glide of the spleen may account for some of the differences among the anatomy textbooks.

It is a fair comment to state that the spleen has an unorthodox and irregular tetrahedral shape, whose curved borders and convex and concave relation surfaces refuse to follow the conventional anatomical planes.

Consequently, any attempt to describe any border or relation surface of the spleen will involve a perplexing minimum of two, if not three, anatomical planes. For example, the superior-anterior border has a medial-lateral tilt or anterior-posterior tilt depending on the precise point along the border. The understanding of the anatomical planes of the spleen is further compounded by photographs and diagrams of the spleen in various anatomical textbooks and atlases being presented in unspecified viewing angles.

The problematic concepts of the glide of the spleen and the inadequacy of anatomical planes lead us to the solution concept of the primacy of the 10th rib. There is an overwhelming consensus that the 10th rib represents the long axis of the middle of the spleen [2, 4, 5, 10, 13, 14] or long axis of the 9th–11th ribs [6, 9]. The primacy of the 10th rib concept makes the 10th rib the main reference landmark for all the borders and relations. The four borders of the spleen based on the primacy of the 10th rib are the 9th rib border, 11th rib border, towards-the-vertebral extremity and the towards-the-xiphoid extremity (Figure 2).

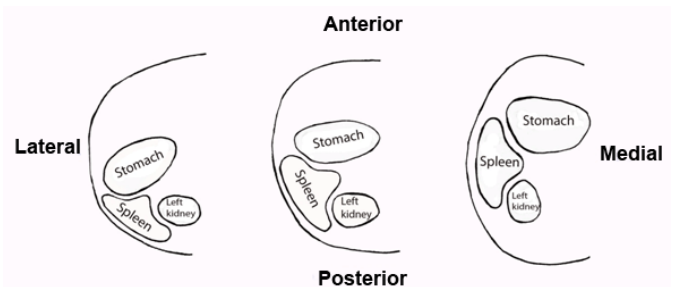


Figure 1: The glide of the spleen.

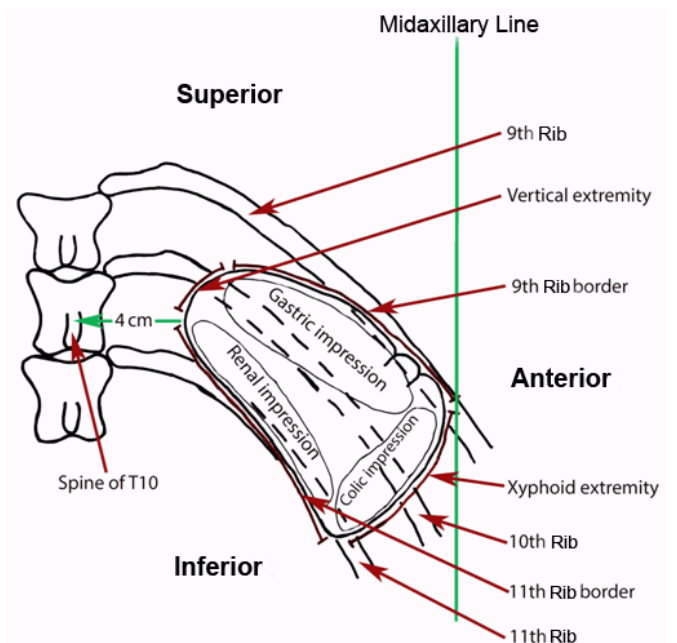


Figure 2: Posterior view diagram showing relations of the spleen.

The relations of the spleen can be described as either being on the superficial or the deep surfaces of the spleen. The stomach will lie deep to the 9th rib, the left kidney deep to the 11th rib and the left colic flexure deep to the xiphoid extremity end near the mid-axillary line, as indicated on Figure 2. The costodiaphragmatic recess and the left lung in full inspiration intervenes between the superficial surface of the spleen and the 9–11th ribs, with the lungs becoming thicker towards the 9th rib (Figure 3).

A transverse section cross section of the spleen on Figure 4 further illustrates the left kidney lying deep to the 11th rib and the stomach lying deep to the 9th rib. Most the anatomy atlases ignore showing the 10th rib in relation to the spleen and show un-numbered ribs in relation to the spleen and other organs, although a photograph in a book by Abrahams et al. [28] is a refreshing exception, which shows numbered ribs in relation to the spleen.

The primacy of the 10th rib has tremendous clinical advantage because the 10th rib is easy to locate and palpate, being the most inferior of the fixed ribs. It should be borne in mind that the 10th rib could unexpectedly be a floating rib in between 35–70% of various populations [8]. Given that the 9th rib is the most oblique of the 12 ribs [8], it is reasonable to expect that the 10th rib is the second most oblique rib. The inclination of the 10th rib is hard to precisely describe using anatomical planes because of the curvature of the rib, diagonal inclination of the rib and the ever constant movement due to breathing. A large area of the spleen is in direct contact with the diaphragm which moves with every breath [33] and Figure 4 illustrates the diaphragm lying superficial to the spleen.

The entire superficial surface of the 10th rib that covers the spleen [10] can be palpated. The regression of the 10th rib back to the vertebral column should lead to the T10 spine, a structure well documented to be 4 cm from the vertebral extremity of the spleen (Figure 2), and palpable. The junction of the 9th rib and the mid-axillary line (both easy to locate surface anatomical landmarks) will mark the junction of the 9th rib border and the towards-the-xiphoid extremity of the spleen, as shown in a Figure 2. The two famous notches of the spleen will be located towards the mid-axillary line end of the 9th rib border of the spleen.

A normal spleen cannot be palpated [23], even in full inspiration [25]. The clinical examination of the spleen is focused on palpation of an enlarged spleen, splenomegaly, where the spleen grows out of the left subcostal margin towards the right anterior iliac spine [23, 32]. Given that a normal spleen cannot be palpated gives credit to the proposed idea that the 11th rib forms the inferior most rib covering the spleen. Rib fractures to the left inferior thorax may severely injure the spleen [6, 12] and the primacy of the 10th rib helps to reinforce the intimacy of the 10th rib to the spleen.

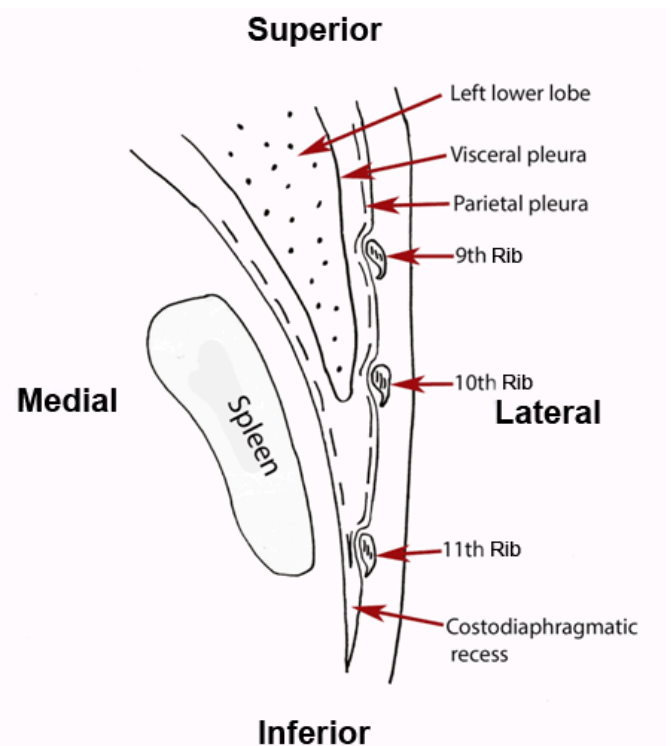


Figure 3: Coronal view showing relations of the spleen.

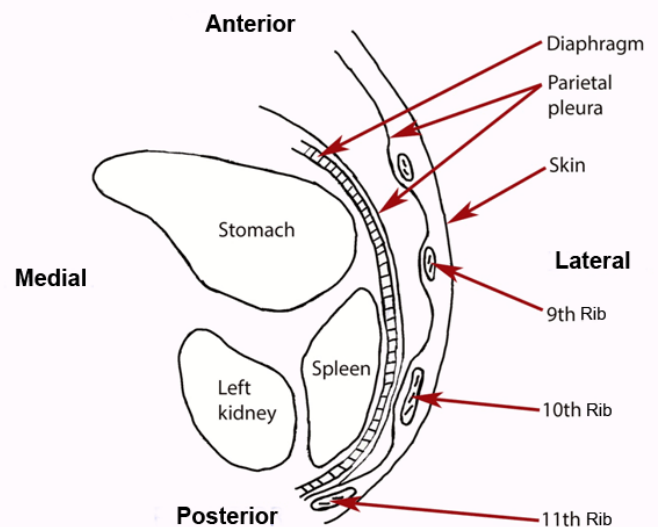


Figure 4: Transverse section between T12 and L1 showing relations of the spleen (modified from a photograph D in [28] p. 251).

The paper has a number of weaknesses. Anatomical textbooks rarely provide references of the basis of their descriptions and there is a possibility of many authors drawing from the same weak references or from each other, although it should be mentioned that most of the authors are highly experienced teachers of anatomy. The borders and relations of the spleen described using the primacy of the 10th rib concept are not absolutely precise, but enable students to understand the most important



concepts of the spleen in a concise manner. It is now well known that the amount of time available for teaching anatomy has drastically been reduced [34] and having concise and clear descriptions makes efficient use of scarce teaching time.

## CONCLUSION

In conclusion, the ‘obliquity of the spleen’ (p. 238) presents a learning challenge for students and a teaching challenge for anatomy teachers, and is probably the root of the inconsistencies of the descriptions borders and relations of the spleen. The concept of the primacy and emphasis of the 10th rib in being the reference point in describing the borders and relations of the spleen in humans is been advocated for, and could make the clinical learning and location of the spleen easier for students and clinicians and better focus the teaching of the spleen.

**Keywords:** Anatomy, Palpation, Spleen, Surface, Teaching

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Hope Gangata – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

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The corresponding author is the guarantor of submission.

### Conflict of Interest

Authors declare no conflict of interest.

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