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To Investigate the Branching Pattern of Segmental Branches of The Splenic Artery in Human Cadaveric Spleens Using the Dissection Technique

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Abstract

Background: The spleen, which is the primary lymphatic organ in the human body, receives its blood supply via the splenic artery, which is the primary branch of the celiac trunk. The structure traverses the lienorenal ligament and reaches the spleen hilum, where it bifurcates into 2-3 primary branches, each of which primarily divides into 2-4 subsidiary branches. Additionally, the inferior and superior polar arteries originate from the principal branches or splenic stem and enter the spleen pole directly without passing via the hilum. **Aim:** To investigate the branching pattern of segmental branches of the splenic artery in human cadaveric spleens using the dissection technique. **Methodology:** The current investigation involves the examination of 60 human cadaver spleens, without considering their age or sex. These spleens were preserved in a 10% formalin solution and were obtained from the Department of Anatomy, Venkateshwara IMS. The splenic artery was transected around 10 cm from the hilum of the spleen, followed by the removal of the spleen. The fascia and fat were removed at the hilum to reveal the segmental branches of the splenic artery. Initially, the main divisions of the splenic artery and any polar arteries were discovered and recorded. Subsequently, the length of these divisions and polar arteries was directly measured using a Digital Vernier Calliper. **Results:** Out of the 42 spleen samples, 70% had two major branches, 25% had three primary branches, and 5% had four primary branches. Out of the total samples, 15 (25%) exhibit superior polar arteries, 24 (40%) exhibit inferior polar arteries, and 3 (5%) exhibit both inferior and superior polar arteries. The superior PB had a range of lengths from 0.55 to 4.45 cm, with an average length of 1.69 cm and a median length of 1.31 cm. The average length of the middle PB varied between 0.41 and 2.18 cm, with an average length of 1.12 cm and a median length of 1.15 cm. The inferior PB exhibited a range of lengths between 0.34 and 5.36 cm, with an average length of 1.91 cm and a median length of 1.74 cm. The maximum diameter of the PB varied from 0.77 mm to 4.23 mm, with an average diameter of 2.31 mm and a median diameter of 2.36 mm. The middle PB exhibited a range of mean diameters from 0.77 mm to 3.74 mm, with an average diameter of 2.15 mm and a median diameter of 2.36 mm. The inferior diameter of the PB varied between 0.69 mm and 4.61 mm, with an average diameter of 2.19 mm and a median diameter of 2.09 mm. **Conclusion:** This research improves the existing knowledge about the morphometry of the segmental branches of the splenic artery, which is crucial for many spleen-sparing procedures that need accurate information about the spleen's vascular architecture.

Keywords: Splenic artery, Polar artery, Segmental branches.

INTRODUCTION

The spleen is the most sizable lymphatic organ in humans. It is linked to the circulatory system. The structure is comprised of a substantial enclosed aggregation of lymphoid and vascular tissues. The blood supply to the spleen is provided via a splenic artery which is a branch of the celiac trunk.[1] The human spleen is abundantly supplied with blood vessels and is easily crumbled, making it unsuitable for suturing.[2] The spleen is an organ that is rich in blood vessels and easily breaks apart. The organ in question is the biggest secondary lymphoid organ, including 25% of the body's lymphoid tissue. It serves both haematological and immunological purposes. The spleen is vascularized by the splenic artery, which is the biggest branch of the celiac trunk.[3] The pathway of the vessel passes via the lienorenal ligament until it reaches the vicinity of the hilum of the spleen.

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At this point, the vessel splits into two or three main branches, each of which further divides into mostly two or four subordinate branches. Furthermore, the splenic trunk or one of its main branches provides both superior polar arteries and inferior polar arteries, which provide blood to the poles of the spleen without passing through the hilum. The branches are referred to as superior and inferior polar branches.[3-5] Michel,[6] states that the splenic artery concludes by bifurcating into 2 or 3 terminal branches, known as the superior, middle, and inferior main branches. The main branches penetrate the spleen via its hilum. Some spleens have a variant where the splenic artery or its main branch gives rise to an artery that does not pass through the hilum, but instead proceeds to one of the poles of the spleen. The branches may be classified as the superior or inferior polar branch. The branches provide blood flow to a specific region of the spleen that is divided by an area without blood vessels. Consequently, these branches partition the spleen into distinct vascular segments.[6] The main section is often further separated into two to four minor segments, which are less consistent. The sections of the spleen are divided by a clearly defined plane that lacks blood vessels. Partial splenectomy is feasible because to the spleen's segmentation, which is characterised by fibrous septa dividing it into several segments, each of

which is independently fed by a major artery. Two The occurrence of splenic segmentation may be linked to its ontogeny or to the terminal bifurcation of the artery.[7-10] Enhanced understanding of the segmental distribution of the splenic artery and its variations is crucial for performing partial splenectomy. In order to enhance our understanding of the segmental branches of the splenic artery and their clinical importance, this study was conducted to examine the division of the spleen into different segments by these branches, their distribution pattern, and the presence of any inter-segmental arterial connections using dissection techniques.

METHODS

The current investigation involves the examination of 60 human cadaver spleens, without considering their age or sex. These spleens were preserved in a 10% formalin solution and were obtained from the Department of Anatomy, Venkateshwara IMS. The gross dissection was performed by according to the instructions outlined in Cunningham's Manual. The spleen was located and released from the back of the abdominal wall and stomach by severing the gastrosplenic and lienorenal ligaments. The splenic artery was transected around 10 cm from the hilum of the spleen, followed by the removal of the spleen. The fascia and fat were removed at the hilum to reveal the segmental branches of the splenic artery. Initially, the main divisions of the splenic artery and any polar arteries were discovered and recorded. Subsequently, the length of these divisions and polar arteries was directly measured using a Digital Vernier Calliper. The Digital Vernier Calliper was used to directly measure the exterior diameter of segmental branches and polar arteries at a distance of 1 cm from their origin. Precautions were made to ensure that the artery is not constricted by the edge of the calliper during the measurement.

RESULTS

Out of the 42 spleen samples, 70% had two major branches, 25% had three primary branches, and 5% had four primary branches. (Table 1) Out of the total samples, 15 (25%) exhibit superior polar arteries, 24 (40%) exhibit inferior polar arteries, and 3 (5%) exhibit both inferior and superior polar arteries. (Table 2). The superior PB had a range of lengths from 0.55 to 4.45 cm, with an average length of 1.69 cm and a median length of 1.31 cm. The average length of the middle PB varied between 0.41 and 2.18 cm, with an average length of 1.12 cm and a median length of 1.15 cm. The inferior PB exhibited a range of lengths between 0.34 and 5.36 cm, with an average length of 1.91 cm and a median length of 1.74 cm. The additional length of PB ranges from 0.39 to 1.58 cm, with an average length of 1.39 cm and a median length of 1.69 cm. The length of the superior polar artery ranges from 0.77 to 6.14 cm, with an average length of 2.79 cm and a median length of 2.54 cm. The length of the inferior polar artery varied between 0.89 and 6.02 cm, with an average length of 3.16 cm and a median length of 3.54 cm. (Table 3.). The maximum diameter of the PB varied from 0.77 mm to 4.23 mm, with an average diameter of 2.31 mm and a median diameter of 2.36 mm. The middle PB exhibited a range of mean diameters from 0.77 mm to 3.74 mm, with an average diameter of 2.15 mm and a median diameter of 2.36 mm. The inferior diameter of the PB varied between 0.69 mm and 4.61 mm, with an average diameter of 2.19 mm and a median diameter of 2.09 mm. The additional diameter of the PB varied between 0.96-4.02 mm, with an average of 2.41 mm and a median of 2.23 mm. The diameter of the superior polar artery varied between 0.48 mm and 3.85 mm, with an average length of 1.59 mm and a median of 1.39 mm. The diameter of the inferior polar artery ranges from 0.45 to 3.01 mm, with an average diameter of 1.41 mm and a median diameter of 1.38 mm. (Table 4)

Table 1: Numeral of splenic artery with its primary segmental branches.

Primary segmental branches	Numeral of specimens =60	Percentage
One	0	0
Two	42	70
Three	15	25
Four	3	5

Table 2: Distribution of Polar artery

Polar artery	Numeral of specimens =60	Percentage
Inferior Polar Artery	24	40
Superior Polar Artery	15	25
None (no polar artery)	18	30
Superior & Inferior Polar Artery (Both)	3	5

Table 3: Length of polar artery and primary segmental branches

Length	Number	Mean	Sd	Min	Max	Median
Superior primary segmental branch	60	1.69	0.36	0.55	4.45	1.31
Middle primary segmental branch	40	1.12	0.37	0.41	2.18	1.15
Inferior primary segmental branch	60	1.91	0.45	0.34	5.36	1.74
Extra primary segmental	3	1.39	0.54	0.39	1.58	1.69
Superior polar artery	15	2.79	0.41	0.77	6.14	2.54
Inferior polar artery	24	3.16	0.64	0.89	6.02	3.54

Table 4: The polar artery and primary segmental branches diameter.

	Number	Mean	Sd	Min	Max	Median
Superior primary segmental branch	60	2.31	0.41	0.77	4.23	2.36
Middle primary segmental branch	40	2.15	0.43	0.77	3.74	2.36
Inferior	60	2.19	0.51	0.69	4.61	2.09

primary segmental branch						
Extra primary segmental	3	2.41	0.61	0.96	4.02	2.23
Superior polar artery	15	1.59	0.39	0.48	3.85	1.39
Inferior polar artery	24	1.41	0.74	0.45	3.01	1.38

DISCUSSION

The spleen is vascularized by the splenic artery, which ends at the hilum by branching into 2 or 3 smaller arteries. These branches are referred to as superior, middle, and lower main branches. The branches provide blood to a specific region of the spleen that is divided by a plane without blood vessels. Therefore, these branches partition the spleen into distinct vascular regions. These arteries might be regarded as the main segmental branches.[11] In this current investigation Out of the 42 spleen samples, 70% had two major branches, whereas 25% had three primary branches, and 5% had four primary branches. Subsequent research demonstrated a mere 2 to 3 main branches. Our investigation has shown the presence of 2 to 4 major branches. The other studies likewise demonstrated the presence of 2 to 4 branches.[12] Some spleens have a branch that originates directly from the splenic artery or one of its main branches. This branch does not pass through the hilum, but instead proceeds to the poles of the spleen. These arteries are referred to as superior and inferior polar arteries. The arteries also provide blood to a specific section of the spleen, which might be referred to as the polar segments. Our investigation revealed that 15 samples (25%) exhibited superior polar arteries, 24 samples (40%) exhibited inferior polar arteries, and 3 samples (5%) exhibited both inferior and superior polar arteries. For surgical treatments involving the access and ligation of arteries, it is crucial to have a thorough understanding of the anatomy of each segmental branch. Our investigation included recording the measurements of both the length and diameter of each major segmental branch and polar branch. The superior PB had a range of lengths from 0.55 to 4.45 cm, with an average length of 1.69 cm and a median length of 1.31 cm. The average length of the middle PB varied between 0.41 and 2.18 cm, with a mean length of 1.12 cm and a median length of 1.15 cm. The inferior PB exhibited a range of lengths, fluctuating between 0.34 and 5.36 cm. The average length was 1.91 cm, while the median length was 1.74 cm. The PB diameter varied between 0.77 mm and 4.23 mm, with an average diameter of 2.31 mm and a median diameter of 2.36 mm. The average diameter of the middle PB varied between 0.77 mm and 3.74 mm, with a median diameter of 2.36 mm and an average of 2.15 mm. The inferior diameter of the PB varied between 0.69 mm and 4.61 mm, with an average diameter of 2.19 mm and a median diameter of 2.09 mm. Similar findings were also obtained by Londhe SR.[21] The research undertaken by Ignjatovic D et al,[22] observed that the extracapsular length of segmental branches varied between 4.0 and 16.7 mm, while their calibres ranged from 0.4 to 2.2 mm. In a research done by Machalek L et al,[23] it was observed that the average diameter of the superior branch was 4.2 mm, whereas the inferior branch had an average diameter of 3.7 mm.

Table 5: Comparison of number of primary segmental branches of splenic artery with the previous studies.

	Number of sample	Primary segmental branches		
		2	3	4
		Percentage		
Swamy VL et al.[12]	60	66	17	17
Chaware PN et al.[13]	0	85.58	14.42	0
Mandarin LCA.[14]	25	68.20	10.60	4.50
Katrisis E et al.[15]	70	88.70	14.30	0
Silva LFA.[16]	0	93.34	6.66	0
Garcia PJA.[17]	181	92.82	7.18	0
Mikhail Y et al.[18]	25	77	23	0
de OLIVEIRA GB.[19]	50	80	20	0
Gutsol AA.[20]	100	84	16	0
Present study	60	70	25	5

Table 6: The comparison of polar arteries with the previous studies.

	Polar artery		
	Superior	Inferior	Both
Londhe SR et al.[21]	32	56	24
Swamy VL et al.[12]	41.60	25	16.60
Chaware PN et al.[13]	28.82	42.34	11.70
Mikhail Yet al.[18]	18	50	12
Garcia PA et al.[17]	29.28	44.75	10.49
Present study	22.80	40.50	6.30

The significance of the spleen in infection prevention was found to be underestimated, with the belief that other lymphatic organs in the body could compensate for its functions. However, it is worth noting that the spleen is the site where both B and T lymphocytes proliferate and play a crucial role in immune responses.[24] Subsequent animal studies and patient follow-up examinations have shown the actual importance of this in avoiding blood borne sepsis. It has been conclusively demonstrated that its role as a blood filter is very significant.[25] Consequently, contemporary surgeons prioritise preserving as much splenic tissue as possible by just excising the affected section of the spleen, despite the substantial evidence in favour of splenectomy. Comprehensive knowledge of the segmental branches of the splenic artery is essential for this.

CONCLUSION

The spleen is a highly vascularized and delicate organ. The spleen is the second largest lymphatic organ, including 25% of the body's lymphoid tissue, and plays important roles in both blood-related and immune functions. Complete splenectomy is often carried out after a spleen damage, which increases the risk of immunosuppression and makes the person more susceptible to life-threatening infections. Additionally, it leads to changes in the blood composition. In order to address this issue, a partial splenectomy may be carried out by ligating the particular branch of the splenic artery. This research improves our existing understanding of the morphometry of the segmental branches of the splenic

artery, which is crucial for different spleen procedures that aim to preserve as much of the spleen as possible.

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