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SPLENIC VASCULATURE AND ARTERIAL SEGMENTATION PATTERNS IN THE HUMAN SPLEEN

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ABSTRACT

Background: Following splenic injury, a partial splenectomy is a surgery that helps to retain healthy splenic tissues and immunity. Branch ligation of the splenic artery is necessary in situations of splenic injury, particularly when the splenic section is removed. Because the splenic artery branches separate the spleen into avascular lobes and segments, a thorough comprehension of the segmental arteries is required.

Aim: The goal of this study was to look at the human spleen's vascular segmentation pattern as well as changes in the splenic arterial pattern.

Methods: Specimens were acquired from cadavers and unclaimed autopsy bodies, and this study examined 62 spleens with intact splenic arteries. Tracing from the segmental and terminal branches of the splenic artery was investigated using piecemeal dissection. After cleansing, the splenic artery's segmental and terminal branches were evaluated. Vascular anastomosis was observed in several segmental spleen arteries as well as adjacent segmental arteries.

Results: The study found that 33.2% and 66.7% of subjects had splenic artery terminations as bifurcation and trifurcation, respectively. The study's findings revealed that the equivalent arterial segments in 6.46% (n=4), 45.16% (n=28), 22.58% (n=14), 9.67% (n=6), 9.67% (n=6), and 6.46% (n=4) specimens were 2, 3, 4, 5, 6, and 7. Except for the specimens with intersegmental artery anastomosis, these segments were separated by an avascular plane.

Conclusions: The current study shows that understanding splenic artery branching patterns can assist general surgeons and surgical gastroenterologists undertake spleen procedures, particularly partial splenectomy after splenic injury. This can also assist anatomists educate and learn about vascular segmentation of the spleen.

Keywords: spleen, segmental artery, intersegmental anastomosis.

INTRODUCTION

The blood vascular system delivers abundant blood flow to the spleen, the largest and most important lymphatic organ. Surgically healing the spleen after an injury is difficult. Following spleen injury, surgeons often remove the entire organ. Complete splenectomy reduces the immunity that typically exists in healthy persons with intact spleens. The surgeons can do a partial splenectomy to protect the spleen's hematological functions and prevent a loss in immunity.1

The spleen, a lymphoid mass with a robust vascular supply, is located in the left hypochondrium, beneath the left ninth, tenth, and eleventh ribs. The splenic artery supplies the spleen, which exits from the celiac artery through the hepatolienogastric trunk.2

The splenic artery often divides into two or three branches at its hilum. Trifurcation terminal branches are referred to as inferior, middle, and superior terminal branches, whereas bifurcation branches that reach the spleen via the hilum are referred to as superior and inferior terminal branches.3

The polar branch refers to any branch of the splenic artery that directly enters the inferior and superior poles of the spleen while avoiding the hilum. An avascular splenic tissue divides the several spleen sections fed by each branch of the splenic artery. These branches split the splenic tissues into discrete circulatory segments.4 Both acute stomach injuries and car accidents can damage the spleen, causing internal bleeding.

Depending on the severity of the sickness, a partial or whole splenectomy may be performed. Partial splenectomy is better for preserving immunological and hematological function, especially in children. Partial splenectomy is now suggested to preserve immunity.5

The closure of splenic artery branches is a critical step in splenic surgery, particularly for segmental resection. Splenic artery branches separate the spleen into avascular segments or lobes, hence a thorough comprehension of segmental arteries is required.[6] The purpose of this study was to investigate the arterial segmentation pattern of the human spleen, as well as alterations in the splenic vascular pattern.

MATERIALS AND METHODS

The purpose of this study was to investigate the arterial segmentation pattern of the human spleen, as well as alterations in the splenic vascular pattern. The research participants were from the Institute's Department of Human Anatomy.

Prior to participating, all people provided written and verbal informed consent. In the current study, 62 cadaveric spleens inspected via dissection were analyzed.The study included subjects with a normal spleen and intact splenic veins. The study's exclusion criteria included pathological abnormalities, congenital malformations, and lacerated or damaged spleen.

The spleens were removed from the abdomen while at least 5 cm of the splenic artery from the hilum remained intact. Following that, the spleens were thoroughly cleaned of debris and fatty tissue using running tap water. After the blood had been cleansed, the tee clots were removed with forceps.

Following that, the specimens were washed with normal saline. Following that, the splenic artery and its branches were inspected and cleaned. The spleen was thoroughly dissected to collect as much information as possible on the route of the segmental arteries, splenic artery, and their branches.8 Next, the splenic vein was removed. After the dissection, the specimen was inspected, and each spleen's splenic artery termination was assessed. The terminal branches of the polar and splenic arteries were examined.

Each spleen included many segmental branches and vascular segments. The segmental and terminal splenic artery branches were color-coded for better visibility. One specimen was also examined for intersegmental arterial anastomosis between neighboring spleen segments.

The collected data were statistically analyzed using SPSS (Statistical Package for the Social Sciences) software version 24.0 (IBM Corp., Armonk, NY, USA) for descriptive measures, Student t-test, ANOVA (analysis of variance), and Chi-square test. The data were presented in the form of mean and standard deviation, as well as frequency and percentage. A p-value of <0.05 was considered.

RESULTS

The purpose of this study was to investigate the arterial segmentation pattern of the human spleen, as well as alterations in the splenic vascular pattern. This study examined 62 spleens with intact splenic arteries, and specimens were obtained from cadavers and unclaimed autopsy remains. Following the removal of the polar arteries, the investigation revealed two unique types of splenic artery termination: trifurcation and bifurcation. Primary terminal branches originating from the splenic artery stem were seen in all cases. In this study, the percentages of splenic artery trifurcation and bifurcation were 33.24±3.90 and 66.71±3.925, respectively. The incidence of bifurcation was much higher than that of trifurcation ($p<0.05$).

The splenic artery's lower and superior terminal branches divide the spleen into two lobes, while its inferior, middle, and superior branches form three lobes. The spleen's polar arteries have an additional lobe. According to the study's findings, 16.13% of the participants (n = 10), 6.48% of the subjects (n = 4), 48.38% of the subjects (n = 30), and 29.04% of the subjects (n = 18) did not have any polar arteries, superior or inferior. Double inferior polar arteries were seen in four of the thirty cases. There are significantly more inferior polar arteries than superior polar arteries ($p < 0.05$).

As a result, the number of splenic artery segments might range between two and seven. Two, three, four, five, six, and seven artery segments were discovered in 6.46%, 45.16%, 22.58%, 9.67%, 9.67%, and 6.46% of the examined specimens, respectively. In each specimen, segmental branches divide the spleen into arterial segments separated by an avascular plane. Furthermore, the study discovered that 3.22% (n=2) of the spleen tissues included an intersegmental vascular anastomosis (Table 2).

DISCUSSION

The corpse and unclaimed autopsy body were utilized to collect specimens for the ongoing study, which included 62 spleens with intact splenic arteries. After the polar arteries were eliminated, the study found two types of splenic artery termination: trifurcation and bifurcation. In all cases, the splenic artery trunk had substantial terminal branches.

The study discovered that the percentages of splenic artery trifurcation and bifurcation were 33.24±3.90 and 66.71±3.925, respectively. The incidence of bifurcation was much higher than that of trifurcation ($p<0.05$). Previous research by Ignjatović D et al. (2000) and Londhe et al. (2013) found comparable incidences of splenic artery bifurcation and trifurcation in their respective studies.

The inferior and superior terminal branches of the splenic artery split the spleen into two lobes, whereas the inferior, middle, and superior branches form three spleen lobes. Polar arteries exhibit an additional splenic lobe. According to the findings, 16.13% (n=10), 6.48% (n=4), 48.38% (n=30), and 29.04% (n=18) of the subjects had no polar artery, both superior and inferior polar arteries, and superior polar arteries, respectively. Four of the 30 spleens with inferior polar arteries showed double inferior polar arteries. There are significantly more inferior polar arteries than superior polar arteries ($p < 0.05$).

As a result, there might be anywhere between two and seven splenic artery segments. These findings were consistent with those reported by Ravikumar V et al. (2011) and Chaware PN et al. (2012), whose findings for polar arteries were identical to those of the current study. The study also discovered that two, three, four, five, six, and seven artery segments were present in 6.46%, 45.16%, 22.58%, 9.67%, 9.67%, and 6.46% of the sample specimens, respectively. The segmental branches of each specimen split the spleen into arterial segments separated by an avascular plane.

The investigation also found an intersegmental arterial anastomosis in 3.22% (n=2) of the spleen specimens. These findings were compatible with those of Gujar SM et al. (2014) and Pandey SK et al. (2013), who also reported the incidence of two, three, four, five, six, and seven artery segments, which were similar to the current study.

CONCLUSION

Within its constraints, the current study comes to the conclusion that general surgeons and surgical gastroenterologists can benefit from understanding splenic artery branching patterns while doing splenic procedures, particularly partial splenectomy after splenic injuries. Anatomists may also use this to teach and learn about the spleen's vascular segmentation. To get a firm conclusion, more evaluation of human cadavers from different geographic locations and in greater quantities is necessary.

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S. No	Primary/terminal branches	Number (n)	Percentage (%)
1.	**Bifurcation**	42	66.7
2.	**Trifurcation**	20	33.2
3.	**Total**	62	100

Table 1: Patterns of splenic artery termination following exclusion of polar arteries

S. No	Arterial segments	Number (n)	Percentage (%)
1.	**Two**	4	6.46
2.	**Three**	28	45.16
3.	**Four**	14	22.58
4.	**Five**	6	9.67
5.	**Six**	6	9.67
6.	**Seven**	4	6.46
7.	**Total**	62	100

Table 2: Arterial splenic segments after including both polar and segmental branches of splenic artery