ORIGINAL RESEARCH PAPER

Anatomy

TORTUOSITY AND BRANCHES OF THE HUMAN SPLENIC ARTERY

KEY WORDS: branches, splenic artery, tortuosity index.

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ABSTRACT

The splenic artery is the largest branch of the celiac trunk. It is remarkable for the extreme tortuosity of its course. To know the anatomy of the tortuosity of the splenic artery and its possible relations with its total number of branches, 61 embalmed cadavers were dissected. The splenic artery was dissected out from the celiac trunk to the splenic hilum. The direct length of the splenic artery-X cm and the curvaceous length of the splenic artery-Y cm from the point of its origin to bifurcation/trifurcation at the splenic hilum was measured in situ using a simple index of tortuosity. The branches of the splenic artery to the pancreas and the stomach were dissected and noted. The correlation coefficient [r] between the total number of branches of the splenic artery and the tortuosity index was found to have a significant relation ($p<0.001$).

INTRODUCTION

Among all the arteries the splenic artery is uniquely noted and debated on for its tortuous course. Williams et al. (1989), describe the splenic artery as *"remarkably tortuous"*; Basmajian and Slonecker (1989) have said that it takes a *"serpentine"* course; McMinn (1990) also describes it as *"tortuous"*. According to Michels (1942), the tortuosity of the splenic artery was described for the first time by Julius Caesar Arantius of Vienna in 1571 (Sylvester et al., 1995).

The splenic artery has a lot of clinical significance because it may become vulnerable in some of the supracolic operations (Waizer et al, 1989) and because a very tortuous splenic artery may cause confusion in the interpretation of MRI and CT images. Hence a cadaveric study was undertaken to know the anatomy of the tortuosity of the splenic artery and its possible relations with the total number of branches of the splenic artery.

MATERIALS AND METHODS

61 embalmed (10% formalin-fixed) cadavers were dissected in the dissection hall of the Department of Anatomy, Seth G.S. Medical College, Mumbai. The abdomen was opened by a midline incision; the layers of the anterior abdominal wall cut. After opening the peritoneal cavity, the stomach and the greater omentum were identified. The greater omentum was divided and the stomach was lifted up. At the upper border of the pancreas, the celiac trunk was located; the splenic artery was then dissected out from the celiac trunk to the splenic hilum. The branches of the splenic artery to the pancreas and the stomach were dissected and noted. Polar arteries were dissected out; their origin and number noted. The direct length of the splenic artery (X cm) from the point of its origin from the celiac trunk to bifurcation/trifurcation was measured *in situ* with the help of a twine thread and a calibrated scale. The curvaceous length of the splenic artery (the twine thread was made to follow all the tortuous curves of the splenic artery from the point of its origin to bifurcation/trifurcation at the splenic hilum-Y cm) was also measured *in situ*. The tortuosity index (T.I.) was calculated as the ratio of the curvaceous length and the direct length of the splenic artery (Y/X) and the average T.I. found. The Pearsons correlation coefficient (r) between the tortuosity index and the total number of branches of the splenic artery was statistically calculated and the probability value for its significance then found out from the't' test.

RESULTS

The straight length of the splenic artery from its origin to the point of hilus branching (X cm) was found to vary from 4.2 to 9.5 cm with an average of 7.03 cm S.D.$\pm$1.07. The total uncoiled (curvaceous) length of the splenic artery from its origin to the point of hilus branching (Y cm) was found to vary from 6.05 to 23.2 cm with an average of 11.39 cm S.D.$\pm$2.79.

The range of the tortuosity index (T.I.) was found to vary from 1.01 to 2.67, with an average of 1.62 S.D.$\pm$0.31. The median of the tortuosity index ratio was found to be 1.56. T.I. of less than 1.5 was observed in 25 cadavers (40.98%); T.I. of 1.5 to 2.0 was observed in 29 cadavers (47.54%); T.I. of 2.1 to 2.5 was observed in 6 cadavers (9.84%); T.I. of more than 2.5 was observed in 1 cadaver (1.64%).

Pancreatic branches varied from 2 to 6, with an average of 3.95 S.D.$\pm$0.88; short gastric arteries varied from 2 to 6, with an average of 3.89 S.D.$\pm$1.08; left gastro-epiploic (LGE) artery was found to be 1 per cadaver; posterior gastric artery (PGA) was seen in 19 cadavers (31.15%); dorsal pancreatic artery (DPA) was seen in 4 cadavers (6.56%). The posterior gastric artery (PGA) was found in 4 females out of a total of 6 females (66.67%). In a female cadaver two PGAs were found. The total number of branches of the splenic artery (Table 1) was found to vary from 5 to 13, with an average of 9.23 S.D.$\pm$1.95. The correlation coefficient [r] between the total number of branches of the splenic artery and the tortuosity index was found to be 0.78, with a highly significant relation ($p<0.001$).

Table 1: Total Number of branches of the Splenic Artery.

Total Branches	n	%
5	2	3.28
6	3	4.92
7	7	11.48
8	8	13.11
9	14	22.95
10	13	21.31
11	6	9.84
12	4	6.56
13	4	6.56
Total	**61**	

Where n= Total number of cases in 61 observations.

The number of hilar sub-segmental arteries (Table 2) were found in the range of 4 to 12, with 6 number of sub-segments commonly found, n=15 (24.59%). Also 4 and 5 number of sub-segments were commonly found, each with n=14 (22.95%).

Table 2: Hilar Sub-segmental branching pattern.

Hilar sub-segmental arteries(mesosplenic)	n	%
4	14	22.95
5	14	22.95
6	15	24.59
7	7	11.48

8	4	6.56
9	2	3.28
10	3	4.92
11	1	1.64
12	1	1.64

n=Number of cases in 61 observations.

A majority of the superior polar artery (SPA) originated as the third order branching from the splenic artery, n=19 (39.58%) and from the splenic trunk, n=17 (35.42%). A majority of the inferior polar artery (IPA) originated as the third order branching from the splenic artery, n=22 (40.0%) and from the spleno-gastroepiploic (SGE) trunk, n=18 (32.73%) [Table 3].

Table 3: Origin of the polar arteries

Origin	SPA 'n'	%	IPA 'n'	%
Splenic trunk	17	35.42	6	10.91
Second order branches	10	20.83	8	14.55
Third order branches	19	39.58	22	40.00
Fourth order branches	2	4.17	1	1.82
Spleno-gastroepiploic trunk	-	-	18	32.73
Total	48	78.69	55	90.16

n=Number of cases in 61 observations.

DISCUSSION

Petroianu A. and Petroianu S. (1994) found 1-13 short gastric arteries in an in-vivo study of splenectomised specimens. Vandamme and Bonte (1986) have noted 3-8 pancreatic branches arising from the splenic artery, upto 9 short gastric arteries, the left gastro-epiploic artery (LGE) arising from the splenic artery. In our study, the pancreatic branches varied from 2 to 6, the short gastric arteries varied from 2 to 6, one LGE invariably arising from the splenic artery.

Vandamme and Bonte (1986) found the posterior gastric artery (PGA) in 36% of their specimens. Sahni et al. (2003) found the PGA in 70 out of 156 male specimens but only in 18 out of 44 female specimens. In our study, 19 out of 61 cadavers showed the presence of PGA and there were two of them in one female cadaver.

Mikhail et al. (1979) found both SPA and IPA in 12% of their specimens. Vandamme and Bonte (1986) found the SPA arising from the cranial border of the splenic artery in 52% of cases and the IPA as a branch of splenogastro-epiploic trunk. Garcia-Porrero and Lemes (1988) observed SPA in 29.28% of 181 cases, 71.7% of these arising from the trunk of the splenic artery. They also observed the IPA in 44.75% of cases, mostly arising from the left gastrosplenic artery. In our cadaveric study, 44 out of 61 specimens showed the presence of both superior and inferior polar arteries; 35.42% of the SPAs arose from the splenic trunk and 40% of the IPAs arose from a third order branch; in 18 cases(32.73%), the IPA arose from the splenogastro-epiploic trunk.

Garcia-Porrero and Lemes (1988) noted that there are subdivisions of the splenic segmental arteries. We found 4 to 12 splenic sub-segmental arteries.

Sylvester et al. (1995), quoting Michels have put forth various reasons for the tortuosity of the splenic artery like respiratory movement and volumetric changes in the spleen; age; growth of the arteries tethered by its branches and associated atheroma etc. Sylvester et al. (1995) found a relationship between the tortuosity of the splenic artery and the age of the patients.

Patel and Fry (1966) attach a lot of importance to tethering and the behavior of the tethered segment of the vessel wall as it can alter the vascular dynamics. According to Dobrin et al (1988), some vessels when pressurized are forced to elongate excessively and to buckle between constraining branches, which is clinically seen as arterial tortuosity. They demonstrated that failure of elastin plays a role in the tortuosity of the splenic arteries in general. As the age increases, there is a degeneration of elastin in the arterial wall, which leads to dilatation and development of tortuosity (Malinovsky et al., 1997). Alan Burton (1972) has noted that there is an increase in the total content of collagen fibers in the arterial wall as age advances and this leads to diffuse fibrosis and increased stiffening of the vessel wall. In our study (n=61), a significant correlation was found between the total number of branches of the splenic artery and the tortuosity index.

CONCLUSIONS

- Majority of the specimens showed the tortuosity index to vary from 1.0 to 2.0.
- A significant correlation was found between the total number of branches of the splenic artery and the tortuosity index ($p<0.001$).

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