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Original Research Paper

Anatomy

A STUDY OF TORTUOSITY OF HUMAN SPLENIC ARTERY

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ABSTRACT

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. The branches of the splenic artery to the pancreas and the stomach were dissected. The tortuosity index-T.I. calculated.

31 celiac angiograms were studied retrospectively to measure the degree of tortuosity of the splenic artery. The direct length of the splenic artery on celiac angiographic plate-X® cm and the curvaceous length of the splenic artery-Y® cm was measured on the same plate from the point of its origin from the celiac trunk to bifurcation/trifurcation in the splenic hilum. The tortuosity index-T.I. ® and the correlation coefficient between the age of the subjects & the T.I. ® found out.

KEYWORDS : Angiograms, Age, Splenic Artery, Tortuosity Index.

INTRODUCTION

The great Roman Physician, Galen, has described the spleen as "an organ full of mystery" (Gilchrist and Trunkey, 1990). It's not just the organ but the artery supplying this organ, the Splenic artery has been the subject of many studies because of its peculiar tortuous course.

According to Michels (1942), the tortuosity of the splenic artery was first described by Julius Caesar Arantius of Vienna in 1571 as *"arteriae lienis, ductum obliquum ac flexuosum, anguis in modum"*, who described it as a duct, oblique and tortuous, like a snake (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), especially in the pancreatico-duodenal surgeries. Knowledge of the normal anatomic pattern is indispensable in order that correct, fairly bloodless incisions be made and life-sustaining arteries be preserved. Hence a study was undertaken: (i) to measure the degree of tortuosity of the splenic artery, using a simple index of tortuosity, by means of cadaveric dissections and celiac trunk angiographic films, (ii) to study the variations in the tortuosity of the splenic artery in Indian subjects and to find out its correlation with the age of the subjects.

MATERIALS AND METHODS

Cadaveric study

61 embalmed (10% formalin-fixed) cadavers were dissected in the dissection hall of the Department of Anatomy, Seth G.S. Medical College and K.E.M. Hospital, Parel, Mumbai, India. The abdomen was opened by a midline incision. All the layers of the anterior abdominal wall were 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 direct length of the splenic artery (X in 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 in 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 tortuosity index then found.

Observational Study On Angiograms

31 celiac angiograms were studied retrospectively (observational study) to measure the degree of tortuosity of the splenic artery. The celiac angiograms were obtained from the Radiology Department of K.E.M. Hospital, Mumbai. The direct length of the splenic artery on celiac angiographic plate (X® in cm), from the point of its origin from the celiac trunk to bifurcation/trifurcation in the splenic hilum was measured 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 by applying twine thread on the film (Y® in cm)] was also measured on the same plate using a twine thread and a calibrated scale. The tortuosity index as seen on the angiograms (T.I. ®) was then calculated as the ratio of the curvaceous length and direct length of the splenic artery (Y®/X®) and the average tortuosity index then found.

The Pearsons correlation coefficient (r) was statistically calculated between the age of the subjects and the curvaceous length of the splenic artery (Y®) as seen on the angiograms. Also, the Pearsons correlation coefficient (r) was statistically calculated between the age of the subjects and the tortuosity index (T.I. ®) as seen on the angiograms. The probability value for its significance then found out from the't' test.

RESULTS

In the cadaveric study (n=61) of the human splenic artery, 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 S.D.$\pm$1.07 cm. The total uncoiled (curvaceous) length of the splenic artery from its origin to the point of hilus branching (Y cm) was found to vary from 6.05 to 23.2 cm with an average of 11.39 S.D.$\pm$2.79 cm.

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%).

Table1: Tortuosity Index (Cadaveric Study) Median=1.56.

TortuosityIndex	Number	%
<1.5	25	40.98

1.5-2.0	29	47.54
2.1-2.5	6	9.84
>2.5	1	1.64
Total	61	

In our angiographic (observational) study (n=31), the straight length of the splenic artery from its origin to the point of hilus branching (X® cm) was found to vary from 3.7 to 11.6 cm with an average of 7.8 S.D.±2.21 cm. 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 7 to 21 cm with an average of 14.17 S.D.±4.28 cm. The Tortuosity index (T.I. ®) varied from 1.15 to 3.06, with an average of 1.8 S.D.±0.5.The median of the tortuosity index ratio was found to 1.77. T.I. ® of less than 1.5 was observed in 10 cases (32.26%); T.I. ® of 1.5 to 2.0 was observed in 11 cases (35.48%); T.I. ® of 2.1 to 2.5 was observed in 6 cases (19.35%); T.I. ® of more than 2.5 was observed in 4 cases (12.90%).

Table 2: Tortuosity Index (Angiographic Study) Median=1.77.

TortuosityIndex	Number	%
<1.5	10	32.26
1.5-2.0	11	35.48
2.1-2.5	6	19.35
>2.5	4	12.90
Total	**31**	

The average age of 31 subjects was found to be 40.13 years, with S.D.±15.32. The correlation coefficient [r] between the age and the curvaceous length of the splenic artery (Y® in cm) was found to be 0.46, with a significant relation ($p<0.01$).

The correlation coefficient [r] between the age and the tortuosity index, was found to be 0.38, with a significant relation ($p<0.05$).

DISCUSSION

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; 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 but not with the degree of atheroma. Sahni et al (2003) found tortuosity of splenic artery only in 10% of adults but not in neonates and hence opine that tortuosity develops with age. We found a significant correlation between the age and the tortuosity of the splenic artery, in 31 cases studied angiographically. Javors (1999) has quoted Michels (1942) that the average length of the splenic artery increases with age. We found the curvaceous length of the splenic artery to vary from 7 to 21 cm and the same was found to have a significant correlation with the age of the subjects ($p<0.01$).

According to Dobrin et al. (1988) in a normal vessel, Fz, the net traction force and FR, the retractive force are equal and opposite and thereby they maintain the stable length of the vessel wall and there is no tortuosity seen. According to them, the retractive force FR is entirely offered by elastin in the vessel wall. In old age, the amount of collagen in the vessel wall increases and the amount of elastin decreases, thereby decreasing the retractive force FR. The intra-luminal pressure, Fp may increase in old age due to hypertension and thus will in turn increase Fz. This combination of increased Fz and decreased FR, results in an effective lengthening of the vessel which if excessive makes the vessel tortuous. Malinovsky (1997) has quoted his own earlier work and mentioned that age-related pathological changes in the elastin content of the vessel wall could be a cause of tortuosity. 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.

CONCLUSIONS

·The average tortuosity index in the angiographic study (n=31) was found to be higher than that in the cadaveric study (n=61).

- Majority of the cases studies, in both the cadaveric and angiographic studies showed the tortuosity index to vary from 1.0 to 2.0.
- In the angiographic study, the age of the subjects was found to have a significant relation with the curvaceous length (Y® in cm) of the splenic artery.
- In the angiographic study, the age of the subjects was found to have a significant relation with the tortuosity index (T.I. ®).

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