

Study on variations in hilar and segmental branching pattern of splenic artery

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Abstract

Background: Introduction of laparoscopic surgical methods requires exact knowledge of the topography of the spleen and its surrounding. Further advances in splenic conservative surgery are dependent on better knowledge of vascular anatomy of the spleen. Hence segmental arteries of spleen are of great surgical importance and their early identification in splenic trauma will lead to enhanced splenic conservation. **Materials and methods:** Present study carried out on 50 human spleen by dissection, silicon injection and radiological methods. We found different types of variations in hilar and segmental branching pattern of splenic artery. **Observations and Results:** in present study splenic artery divided in two primary branches in 86% and in three primary branches in 14% of the spleens. superior polar branches were found in 44% while inferior polar branches were in 52% of the spleens. Two segmental branches found in 24%, three segmental found in 50%, four segmental in 18% and five segmental in 8% of the specimens. Intersegmental anastomosis found in 2% of spleens. **Discussion:** These segmental resection of spleen and further advances in splenic conservation are dependant on better understanding of vascular anatomy of the spleen.

Keywords: Splenic artery, hilar branches, segmental arteries

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INTRODUCTION

The human spleen is an organ demanding constant attention from anatomical, immunological, surgical and clinical point of view. The spleen shows segmentation due to fibrous septa described by Kyber¹ (1870) in man, cat, dog, horse and rabbit. Partial splenectomy was first performed in 19th century and its post operative sequel and complications were observed (Greco and Alvarez, 1981)².

Thus the application of conservative surgery of partial splenectomy became a worldwide practice. Gupta *et al.*³ (1976) reported the avascular plane and the segmental pattern of the spleen like those in other species. Each segment is having hilar branch of the main splenic artery and splenic vein. The application of the conservative splenic surgery requires a detailed knowledge of the avascular plane of the spleen and its segmental pattern in both male and female (Chakravarthy S, 2003)⁴. The splenic artery divides into two or three primary or hilar branches [terminal branches]. The arteries supplying one of the poles of the spleen are polar arteries (Michel NA)⁵. A vessel is considered as polar artery, when it penetrates one of the splenic poles and not the hilum. There is presence of superior polar branch [which supply posterior pole / extremity] or inferior polar branch [which supply anterior pole / extremity] or both; superior and inferior polar branches. These polar branches may originate from primary branches of splenic artery or from the trunk of splenic artery itself. The human spleen is divided

accordingly into two or three primary segments, separated by a definite avascular plane. Also, a rather constant avascular plane separates the polar segments from remaining of the organ. Thus, the number of segments of spleen, may vary from two to five. The arteries supplying these segments are segmental arteries.

MATERIALS AND METHODS

Total Fifty human spleens out of that forty nine from the embalmed cadavers from Department of Anatomy and one postmortem specimen of human spleen from Department of Forensic, of various medical colleges were obtained for the study. The spleens were stored in 40% formalin solution in different jars and numbered serially.

1. Dissection method:

The spleen was removed along with long splenic artery from origin. The soft tissue (fat) attached to hilum was removed to expose the branches of splenic artery. After that each spleen was dissected carefully by piece-meal dissection method. The splenic artery and its branches were cleaned and traced. Segmental branches of splenic artery were identified and traced individually. The pattern of branching was seen for each spleen. Any variation in

form of number of segmental branches and intersegmental anastomosis if present, was noted and photographed.

2. Silicon injection method:

Spleens were collected from the Anatomy department. The splenic artery was dissected and warm saline was injected into the artery. The spleen was then placed for about an hour with the artery turned downwards to drain out the fluid. Then the silicon gum, loaded in 5ml syringe with 16 bore needle, was injected into the splenic artery. The specimen was kept for 48 hours to allow the silicon gum to settle. Then it was boiled in hot water bath for 15-25 minutes to take off the splenic tissue. The resulting cast was cleaned carefully and then dried. Hilar branches and segmental branches were observed, specimen was numbered and photograph taken.

3. Radiological method:

Fresh spleen was collected from the department of Forensic. The splenic artery was dissected and warm saline was injected into the artery. The spleen was then placed for about an hour with the artery turned downwards to drain out the fluid. Then Barium sulfate-- liquid contrast solution was injected into the splenic artery. The spleen was kept overnight in refrigerator. On next day radiographs were taken. The radiographs were studied and the hilar branches and segmental branches of splenic artery were noted down.

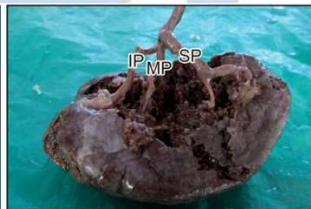
OBSERVATIONS AND RESULTS

In the present study, fifty human spleens were observed to study hilar and segmental branches of splenic artery.

- I. 43 spleens were examined by dissection method.
- II. 06 spleens were examined by silicon injection cast method.
- III. 01 spleen was examined by radiological method.



Photograph 1



Photograph 2



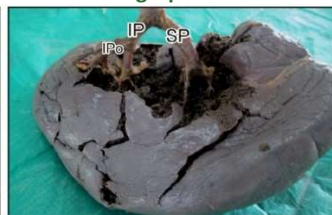
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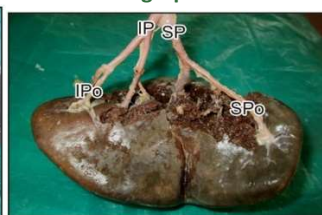
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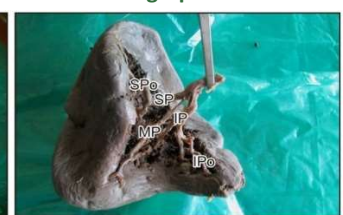
Photograph 5



Photograph 6



Photograph 7



Photograph 8

Photograph 1: Two primary branches, [SP - Superior Primary, IP – Inferior Primary]; **Photograph 2:** Three primary branches, [SP –Superior Primary, MP – Middle Primary, IP – Inferior Primary]; **Photograph 3:** Superior polar branch arising from splenic trunk, [SPo – Superior Polar]; **Photograph 4:** Superior polar branch arising from superior primary branch; **Photograph 5:** Inferior polar branch arising from splenic trunk [IPo – Inferior Polar]; **Photograph 6:** Inferior polar branch arising from inferior primary branch; **Photograph 7:** Two primary and two polar branches; **Photograph 8:** Three primary and two polar branches;



Photograph 9: Three primary and one superior polar; **Photograph 10:** Three primary and one inferior polar



Photograph 11: Vascular anastomosis betⁿ segmental branches; **Photograph 12:** Silicon injection cast; **Photograph 13:** Radiological study

Table 1: Primary or Hilar division of splenic artery

Sr. No.	No. of primary / hilar branches	No. of spleen	Percentage
1	Two	43	86%
2	Three	07	14%

Table 2: Frequency of polar arteries

Sr. No.	Polar artery	No. of spleen	Percentage
1	Superior	12	24%
2	Inferior	16	32%
3	Both; superior and inferior	10	20%
4	Polar arteries absent	12	24%

Table 3: Origins Of Superior Polar Artery

Sr. No.	Origin from	No. of spleens	Percentage
1	Splenic trunk	03	13.63%
2	Superior primary branch	19	86.37%
3	Inferior primary branch	---	---

Table 4: Origin of inferior polar artery

Sr. No.	Origin from	No. of spleens	Percentage
1	Splenic trunk	06	23.07%
2	Inferior primary branch	20	76.93%
3	Superior primary branch	---	---

Table 5: Association between polar branches and primary / Hilar branches

Primary / Hilar branches	Polar branches		
	Superior	Inferior	Both
Two	10	15	06
Three	02	01	04

From table no.1 and 5, it is clear that-

I. Splenic artery divided into two primary [Hilar / terminal] branches in 43[86.00%] spleens.

Out of 43 spleens-

A. Ten spleens showed presence of one superior polar artery and two primary / hilar branches [table no.5].

So in ten spleens, there were three segmental branches. [Photograph no.3 and 4].

B. Fifteen spleens showed presence of one inferior polar artery and two primary / hilar branches [table no. 5]. So in fifteen spleens, there were three segmental branches. [Photograph no.5 and 6].

- C. Six spleens showed presence of both superior and inferior polar arteries and two primary / hilar branches [table no. 5]. Thus in six spleens, four segmental branches were seen.[Photograph no.7 and 12].
- D. In twelve spleens, splenic artery divided into two primary / hilar branches and was not giving any polar branch [table no. 2]. So, in twelve spleens there were only two segmental branches.[Photograph no.1 and 13].
- II. Splenic artery divided into three primary [Hilar / terminal] branches in 07 [14.00%] spleens. [table no.1]

Out of those 07 spleens –

- E. In two spleens, there was one superior polar artery and three primary / hilar branches [table no. 5]. Thus in two spleens there were four segmental branches. [Photograph no.9].
- F. In one spleen there was one inferior polar artery and three primary / hilar branches [table no. 5]. Thus in one spleen four segmental branches were observed. [Photograph no.10].
- G. In four spleens there were both; superior and inferior polar arteries and three primary / hilar branches [table no. 5]. So in four spleens five segmental branches were observed. [photograph no.8].

From above observations, it is clear that the number of segmental branches varied from two to five. The segmental branches were as follows:

1. Two segmental branches - in 12 spleens (24%) [table no. 2 photograph no. 11 and 13]
2. Three segmental branches - in 25 spleens (50%) that is 10 superior polar and 15 inferior polar. [table no. 5 photograph no. 3,4,5,6]
3. Four segmental branches - in 09 spleens (18%) that is 6 spleens showing 2 primary / hilar and both superior and inferior polar, 1 spleen with 3 primary / hilar and 1 inferior polar, 2 spleens with 3 primary and 1 superior polar [table no. 5 photograph no. 7 and 12]
4. Five segmental branches - in 04 spleens (8%) that is 3 primary / hilar and 1 superior and inferior polar each. [table no.5 photograph no. 8]

Interarterial anastomosis

In spleen no. 7, splenic artery divides into three primary branches superior, middle and inferior. It is observed that there is vascular anastomosis between superior and middle primary / hilar branches of splenic artery. [Photograph no.11] So in only one spleen [2%] interarterial anastomosis was present.

DISCUSSION

As reported by Michel NA⁵ (1942), Gupta *et al.*³ (1976), Mikhail *et al.*⁶ (1979) Garcia *et al.*⁷ (1988) and many other research workers and as mentioned in Gray's anatomy

(39th edition 2005), in the present study also, many variations were found in the polar and segmental branches of splenic artery. Two primary branches; superior and inferior were observed in 86% specimens and three primary branches; superior, middle and inferior were observed in 14% specimens in present study. These observations are in agreement with previous studies . Michel NA⁵ had found 80% two and 20% three primary branches. Gupta *et al.*³ had found 84% two and 16% three primary branches. Mikhail *et al.*⁶ had found 77% two and 23% three primary branches. Katritsis *et al.*⁸ had found 85.70% two and 14.30% three primary branches. Chaware *et al.*⁹ had found 85.58% two and 14.42% three primary branches. Superior polar arteries were found in 44% and inferior polar arteries were found in 52% spleen. These finding also are in agreement with findings of previous studies. Michel NA⁵ had found 65% superior polar and 82% inferior polar arteries. Katritsis *et al.*⁸ had found 60% superior and 80% inferior polar arteries. Chaware *et al.*⁹ had found 40.53% superior and 54.06% inferior polar arteries. The origin of polar arteries was variable. Superior polar artery originated from superior primary branch in 86.37% spleens and from splenic trunk in 13.63% spleens. Inferior polar artery originated from inferior primary branch in 76.93 % and from splenic trunk in 23.07% spleens. These findings were in accordance with Michel NA⁵ (1942) and Garcia and Lemes⁷ (1988). They reported origin of polar arteries from superior and inferior primary branches and from splenic trunk. They also reported rare origin of arteries from left gastric artery and from short gastric artery, which was not observed in the present study. In the present study two segmental branches were present in 24% spleens, three segmental branches in 50% spleens, four segmental branches in 18% spleens, five segmental branches in 8% spleens. These observations are not in relation with previous studies as . Mandarin *et al.*¹⁰ had found that two segmental branches were present in 68.2% spleens, three segmental branches in 10.6% spleens, four segmental branches in 4.5% spleens, five segmental branches in 6.7% spleens. Chaware *et al.*⁹ had found that two segmental branches were present in 13.51% spleens, three segmental branches in 60.66% spleens, four segmental branches in 17.11% spleens, five segmental branches in 2.7% spleens. Thus no. of segmental arteries are highly variable. Variations in segmental branches of splenic artery depends upon its development. Spleen appears at first as a number of lobules in the dorsal mesogastrium. These lobules join together to form a single splenic mass. These embryological facts points out variations in segmental branches of splenic artery. In most of the studies carried out earlier, only in three studies there was vascular anastomosis between adjacent segments of spleen. In the present study, intersegmental anastomosis

was found in 2% of the total spleens. Mandarim *et al.*¹⁰ had found 16.7%, Garcia *et al.*⁷ had found 19.8%, Chaware *et al.*⁹ had found that 1.80% spleens.

CONCLUSIONS

In the present study, splenic artery divided into two primary branches in 86% and into three primary branches in 14% of the spleens. Superior polar branches were found in 44% while inferior polar branches were in 52% of the spleens. The primary branches and polar branches of splenic artery which supplied the corresponding lobes of the spleen and divided spleen into segments, separated by a definite avascular plane, are called as segmental branches. In the present study number of segmental branches varied between two to five. Two segmental branches were found in 24%, three segmental branches in 50%, four segmental branches in 18% and five segmental branches in 8% of the specimens. In the present study intersegmental anastomosis was found in 2% of the spleens.

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