INTRODUCTION

Surgical removal or transcatheter ablation of splenic parenchyma is often performed for the management of hypersplenism, a pathologic condition that is characterized by increased pooling or destruction of the corpuscular elements of the blood by the spleen ***(Peck-Radosavljevic, 2001).***

Hypersplenism may be seen in many disorders, including cirrhosis with portal hypertension, hematologic abnormalities such as idiopathic thrombocytopenic purpura, thalassemia major and hereditary spherocytosis and diffuse splenic infiltration from primary malignancies such as leukemia and lymphoma ***(Maddof et al., 2005).***

Total splenectomy may be an effective treatment for hypersplenism, but it impairs the body's ability to produce antibodies against encapsulated microorganisms and predisposes patients to sepsis ***(Sangro et al., 1993).***

The use of splenic arterial embolization also has been advocated for the intentional infarction of splenic tissue to reduce its consumptive activity. In ***1973, Maddison*** reported the initial clinical experience with splenic arterial embolization for this purpose, but severe complications of complete splenic infarction prevented its acceptance as a viable treatment option. Since then, many authors have advocated incomplete or partial splenic arterial embolization, in which a portion of the splenic

parenchyma is left viable to preserve the spleen's immunologic function ***(Koconis et al., 2007).***

Partial splenic arterial embolization (PSE) is an effective short-term therapeutic alternative to splenectomy for a wide spectrum of patients with hypersplenism ***(Kimura et al., 2002).***

Complications of PSE include daily intermittent fever (below 39°C), abdominal pain, nausea and vomiting, abdominal fullness, appetite loss, and postembolization syndrome ***(Sakai et al., 2002).***

PSE can reduce the incidence of splenic abscess, but some reports have documented the development of splenic abscess after PSE ***(Sakai et al., 2002, Vujic- and –Lauver, 1981, Jones and de Koos, 1984).***

AIM OF THE WORK

The aim of this work is to:

- Study the effect of partial splenic embolization on platelet values in patients with chronic liver disease and hypersplenism who have platelet count <80000.
- Determine possible complications of the maneuver and possible risk factors.

ANATOMY AND DEVELOPMENT OF THE SPLEEN

The spleen is the largest organ derived from mesenchyme and lies in the mesentery. It consists of masses of lymphoid tissue of granular appearance located around fine terminal branches of veins and arteries. These vessels are connected by modified capillaries called splenic sinuses ***(Brehdolan et al., 2007).***

Approximately 10% of people have one or more accessory spleens. They may form near the hilum of the main spleen, the junction at which the splenic vessels enter and leave the organ ***(Karakas et al., 2005).***

The human spleen is located in the upper left part of the abdomen behind the stomach and just below the diaphragm. In normal individuals this organ measures about 125 × 75 × 50 mm (5 × 3 × 2 inches) in size, with an average weight of 150 grams ***(Brehdolan et al., 2007).***

Development:

The spleen appears about the fifth week as a localized thickening of the mesoderm in the dorsal mesogastrium above the tail of the pancreas. With the change in position of the stomach the spleen is carried to the left, and comes to lie behind the stomach and in contact with the left kidney. The part of the dorsal mesogastrium which intervened between the spleen and

the greater curvature of the stomach forms the gastrosplenic ligament ***(Brehdolan et al., 2007).***

Relations:

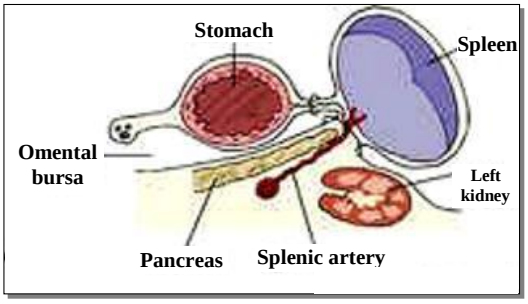

Figure (1): Shows relations of the spleen ***(Cesta, 2006).***

The diaphragmatic surface (facies diaphragmatica; external or phrenic surface) is convex, smooth, and is directed upward, backward, and to the left, except at its upper end, where it is directed slightly medialward. It is in relation with the under surface of the diaphragm, which separates it from the ninth, tenth, and eleventh ribs of the left side, and the intervening lower border of the left lung and pleura ***(Gray, 2005).***

The visceral surface is divided by a ridge into an anterior or gastric and a posterior or renal portion.

The gastric surface (facies gastrica), which is directed forward, upward, and medialward, is broad and concave, and is in contact with the posterior wall of the stomach; and below this with the tail of the pancreas. It presents near its medial border a

long fissure, termed the hilum. This is pierced by several irregular apertures, for the entrance and exit of vessels and nerves ***(Gray, 2005).***

The renal surface (facies renalis) is directed medialward and downward. It is somewhat flattened, is considerably narrower than the gastric surface, and is in relation with the upper part of the anterior surface of the left kidney and occasionally with the left suprarenal gland ***(Gray, 2005).***

The superior extremity (extremitas superior) is directed toward the vertebral column, where it lies on a level with the eleventh thoracic vertebra. The lower extremity or colic surface (extremitas inferior) is flat, triangular in shape, and rests upon the left flexure of the colon and the phrenicocolic ligament, and is generally in contact with the tail of the pancreas ***(Gray, 2005).***

The anterior border (margo anterior) is free, sharp, and thin, and is often notched, especially below; it separates the diaphragmatic from the gastric surface. The posterior border (margo posterior), more rounded and blunter than the anterior, separates the renal from the diaphragmatic surface; it corresponds to the lower border of the eleventh rib and lies between the diaphragm and left kidney. The intermediate margin is the ridge which separates the renal and gastric surfaces. The inferior border (internal border) separates the diaphragmatic from the colic surface ***(Gray, 2005).***

The spleen is almost entirely surrounded by peritoneum, which is firmly adherent to its capsule. It is held in position by two folds of this membrane. One, the phrenicolienal ligament, is derived from the peritoneum, where the wall of the general peritoneal cavity comes into contact with the omental bursa between the left kidney and the spleen; the lienal vessels pass between its two layers. The other fold, the gastrolienal ligament, is also formed of two layers, derived from the general cavity and the omental respectively, where they meet between the spleen and stomach. The short gastric and left gastroepiploic branches of the lienal artery run between its two layers. The lower end of the spleen is supported by the phrenicocolic ligament ***(Gray, 2005).***

The size and weight of the spleen are liable to very extreme variations at different periods of life, in different individuals, and in the same individual under different conditions. In the adult it is usually about 12 cm. in length, 7 cm. in breadth, and 3 or 4 cm. in thickness, and weighs about 200 grams. At birth its weight, in proportion to the entire body, is almost equal to what is observed in the adult, being as 1 to 350; while in the adult it varies from 1 to 320 and 400. In old age the organ not only diminishes in weight, but decreases considerably in proportion to the entire body, being as 1 to 700. The size of the spleen is increased during and after digestion, and varies according to the state of nutrition of the body, being large in highly fed, and small in starved animals. In some pathological conditions like malaria it becomes much enlarged,

reaching occasionally as much as 9 kilograms ***(Karakas et al., 2005).***

Bloodvessels of the Spleen:

The Splenic artery:

The splenic artery is the largest branch of the coeliac trunk. It lies posterior to the omental bursa and extends along the superior margin of the pancreas to the splenic hilum. It is composed of 4 anatomic divisions, including suprapancreatic, pancreatic, prepancreatic and prehilar segments ***(Arinci and Elhan, 1995).***

The suprapancreatic segment is between the origin of the splenic artery and pancreas, which curves anterior to the aorta and reaches the superior margin of the pancreas. The pancreatic segment is the most tortuous part of the splenic artery and extends along a groove located on the posterosuperior surface of the pancreas, although its course may rarely be off the pancreas. The prepancreatic segment crosses the upper border of the pancreas and lies obliquely and anteriorly. The prehilar segment lies between the pancreatic tail and the splenic hilum and is the terminal part of the splenic artery ***(Arinci and Elhan, 1995).***

The splenic artery supplies the spleen and substantial portions of the stomach and pancreas ***(Kadir et al., 1991).***

The splenic artery courses superior and anterior to the splenic vein, along the superior edge of the pancreas ***(Madoff et al., 2005).***

Near the splenic hilum, the artery usually divides into superior and inferior terminal branches, and each branch further divides into four to six segmental intrasplenic branches ***(Madoff et al., 2005).***

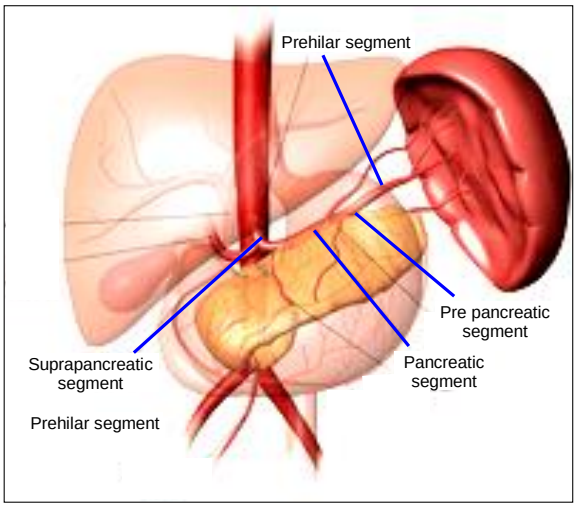

Figure (2): Shows segments of splenic artery ***(Madoff et al., 2005).***

The superior terminal branches are usually longer than the inferior terminal branches and provide the major splenic arterial supply. A superior polar artery usually arises from the distal splenic artery near the hilum, but it may originate from the superior terminal artery. The inferior polar artery usually gives rise to the left gastroepiploic artery, but the latter may also arise from the distal splenic or inferior terminal artery. The

left gastroepiploic artery then runs along the greater curvature of the stomach. Numerous short gastric branches arise from the terminal splenic or left gastroepiploic artery to supply the gastric cardia and fundus ***(Madoff et al., 2005).***

Each branch runs in the transverse axis of the organ, from within outward, diminishing in size during its transit and giving off in its passage smaller branches, some of which pass to the anterior, others to the posterior part. These ultimately leave the trabecular sheaths, and terminate in the proper substance of the spleen in small sinuses ***(Sindel et al., 2001).***

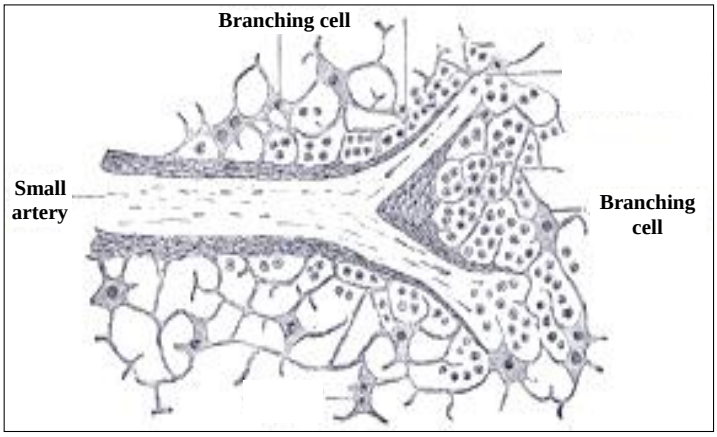

Figure (3): Shows termination of an arteriole ***(Sindel et al., 2001).***

Each of the larger branches of the artery supplies chiefly that region of the organ in which the branch ramifies, having no anastomosis with the majority of the other branches (splenic lobes) ***(Sindel et al., 2001).***

Small veins emerge from the sinuses, which after a short course acquires a coat of ordinary connective tissue, lined by a layer of flattened epithelial cells which are continuous with the supporting cells of the pulp. The smaller veins unite to form larger ones; these do not accompany the arteries, but soon enter the trabecular sheaths of the capsule, and by their junction form six or more branches, which emerge from the hilum, and, uniting, constitute the lienal vein, the largest radicle of the portal vein ***(Gray, 2005).***

Clinical importance:

The splenic artery has many branches that supply the pancreatic body and tail. The first large branch is the dorsal pancreatic artery, and the second large branch is the greater pancreatic artery (or arteria pancreatica magna), which arises from the middle segment of the splenic artery. When embolization is planned, visualization of the pancreatic arteries is essential to reduce the risk of their unintended embolization ***(Madoff et al., 2005).***

In all anatomical and radiological examinations, the distance between the origin of pancreatic branches and the splenic hilum was measured by an experienced anatomist and radiologist respectively. Radiological measurements were corrected by the magnification factor, determined using the patient to image distance (PID) and the source to image distance (SID) ***(Sindel et al., 2001).***

In anatomical measurements, the average distance between the origin of the last pancreatic branch and the splenic hilum was 3.9 ± 0.78 cm (mean ± standard deviation). In one cadaver, the last pancreatic branch originated from the gastroepiploic artery. On selective splenic angiograms, the average distance between the origin of the last pancreatic branch and the splenic hilum was 3.75 ± 0.68 cm. There was no statistically significant difference ***(Sindel et al., 2001).***

Structure of the spleen

The spleen is invested by two coats: an external serous and an internal fibroelastic coat ***(Brehdolan et al., 2007).***

The external or serous coat (tunica serosa) is derived from the peritoneum; it is thin, smooth, and in the human subject intimately adherent to the fibroelastic coat. It invests the entire organ, except at the hilum and along the lines of reflection of the phrenicolienal and gastrolienal ligaments ***(Cesta, 2006).***

The fibroelastic coat (tunica albuginea) invests the organ, and at the hilum is reflected inward upon the vessels in the form of sheaths. From these sheaths, as well as from the inner surface of the fibroelastic coat, numerous small fibrous bands, trabeculae are given off in all directions; these uniting, constitute the frame-work of the spleen. The spleen therefore consists of a number of small spaces or areolae, formed by the trabeculae; in these areolae is contained the splenic pulp ***(Cesta, 2006).***

The fibroelastic coat, the sheaths of the vessels, and the trabeculae, are composed of white and yellow elastic fibrous tissues, the latter predominating. It is owing to the presence of the elastic tissue that the spleen possesses a considerable amount of elasticity, which allows of the very great variations in size that it presents under certain circumstances ***(Elmore, 2006).***

The spleen contains two distinct tissues: red pulp and white pulp. There is a large volume of erythrocytes within the red pulp. The red pulp is composed of slender and non anastomosing arterial vessels, thin-walled venous vessels called splenic sinuses, plates of cells called splenic cords that lie between sinusoids, and red pulp veins that drain the sinusoids ***(Abbott et al., 2004).***

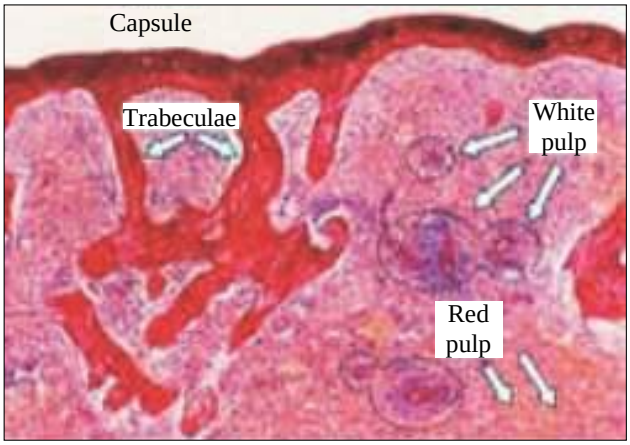

Figure (4): Shows histological structure of the spleen ***(Cesta, 2006).***

The white pulp is composed of lymphatic tissue. The organization of lymphoid cells within the white pulp is similar to that found in the cortex of a lymph node. T cells are usually found in the periarteriolar sheath and B cells are found in primary and secondary follicles. Lymphoid follicles (malpighian corpuscles) have a central artery that is surrounded by a germinal center, mantle zone, and marginal zone. The marginal zone is the transition between the white and red pulp ***(Abbott et al., 2004).***

The nerves are derived from the celiac plexus and are chiefly non-medullated. They are distributed to the bloodvessels and to the smooth muscle of the capsule and trabeculae ***(Gray, 2005).***

PHYSIOLOGY OF THE SPLEEN

As the largest secondary lymphoid organ, the spleen has a number of important roles in immune response, including the clearance of effete or damaged cells from the bloodstream, host resistance to infection ***(Wang and Fan, 2005).***

The central functions of the spleen such as phagocytosis, immunological reactivity, hematopoiesis, and blood cell storage are derived from its clearance capacities, which depend upon the filtration beds between terminal arterial vessels and proximal venules ***(Bowdler, 2002).***

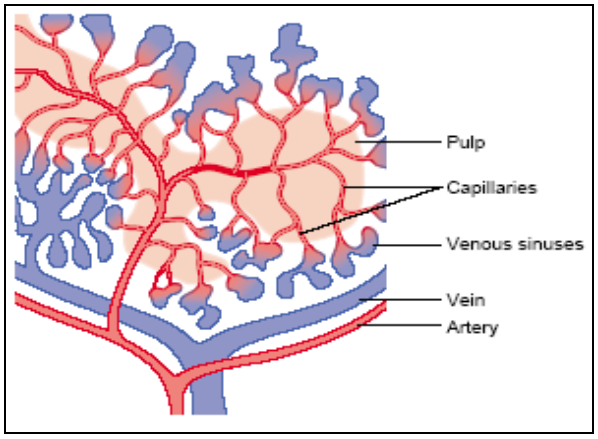

Figure (5): Shows Functional structure of the spleen ***(Guyton and Hall, 2006).***

The Spleen as a Reservoir for Storing Red Blood Cells:

The spleen has two separate areas for storing blood: the venous sinuses and the pulp. The sinuses can swell the same as