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Splenic injury and its management

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Summary

Review of our material demonstrates that the spleen is the most commonly injured intraperitoneal organ. Diagnosis of splenic injury is based on physical examination, detection of hemoperitoneum and imaging of the spleen by means of ultrasonography, radioisotope Tc scan and computed axial tomography. The latter provides a thorough assessment of the traumatized child and contributes to the detection of concomitant injuries. Excision of the injured spleen should be condemned. The spleen is actively involved in the immune defences with trappig of particulate antigens, phagocytosis and antibody production. The risk of postplenectomy sepsis is greatest in the first 2 years postoperaitvely and occurs more frequently in children aged under 5 years postoperatively and occurs more frequently in children aged under 5 years. This complication develops in 1,5% of splenectomized patients with a mortality rate of 50%. Nonoperative management is the teratment of choice in more than 90% of the ceses. Deterioration of vital signs, the need of almost half of blood volume replacement and the presence of concomitant intra-abdominal injuries require abdominal exploration. These rare cases are usually successfully treated by splenorrhaphy and/or, application of tissue adhesives or haemostatic agents on the tear. Injuries involving major branches of the splenic artery or injuries causing partial amputation of the spleen are succesfully dealt with by ligating the splenic artery plus splenorrahaphy or partial splenectomy. In the extreme case of total separation of the spleen from its blood supply, heretotopic autotransplantation of splenic tissue should be undertaken.

Key words: *Splenic trauma, modes of treatment.*

Incidence of splenic injury

Review of our material of the last twenty years demonstrated that the spleen is the most commonly injured intraperitoneal organ in children. The admissions rate of splenic injury cases was 3,8 per year. There is a predominance of splenic injury recorded in males over females and in school age children over younger children. The majority of splenic injuries occurred following blunt abdominal trauma from a direct blow. Regarding trauma causing factors, traffic accidents (including fall from bicycle) are fall from a height or a horse or blow to the abdomen. Penetrating wounds involving the spleen or injuries of the spleen secondary to a rib fractures were extremely rare.

Clinical presentation and diagnosis

The main symptom of splenic injury is abdominal pain. Less than 50% of the patients complain for pain in the ipsilateral shoulder, nausea or vomiting, chest pain and respiratory symptoms. Tenderness in the left upper quadrant of the abdomen, abrasions, or ecchymoses are suggestive of the possibility of splenic injury. The proximity of the spleen to the diaphragm may cause referred pain to the left shoulder. Because concomitant splenic and left renal injury can readily occur, hematuria either macroscopic or microscopic suggest the possibility of splenic injury. Tachycardia, pallor, delayed capillary refill, and progressive lowering of hemoglobin or hematocrit values are diagnostic of blood loss. Free blood in the peritoneal cavity is a consequeence of splenic or liver rupture in the majority of children with abdominal trauma.

If the patient's condition does not require laparotomy for hemostasis, injury of the spleen can be accurately diagnosed by means of imaging techniques. These include x-ray studies, radioisotope scanning with 99 Tc, ultrasound scanning and computed axial tomography [5,9]. Plain radiographies of the chest and abdomen may not always reveal splenic injury. The absence of the shadow of the spleen in combination with medial gastric

displacement, downward displacement at the splenic flexure and, rarely, fracture of the ipsilateral lower ribs, are suggestive of splenic injury. Ultrasound imaging contributes accurately to the diagnosis of both splenic injury and hemoperitoneum. Ultrasound scanning has been established as a standard procedure upon admission of a patient with abdominal trauma. Scanning with 99 Tc is diagnostic and especially useful in defining splenic injury in young children or in restless and uncooperative children. Computed axial tomography reveals the splenic injury in anatomical detial and gives the opportunity of a thorough assessement of the traumatized patient.

Mechanism of splenic injury

Studies of the anatomy of the spleen demonstrated a radial orientation of segmental arterial blood supply. Multiple septa directed from the capsule inward divide the spleen in parenchymatous subsegments of spongy tissue with few blod vessels. Most lacerations of the spleen following blunt abdominal trauma are transverse with a direction from the curved surface to the hilum; they usually do not divide any major arterial branch. On the basis to its relation with the vascular anatomy of the spleen, splenic injury has been classified as follows [35].

Type I-incomplete parenchymal tear.
TypeII-parenchymal tear extending up to the hilum but not dividing it.
Type III-parenchymal tear dividing the spleen into two fragments, each with an intact blood supply.
Type IV-fragmentation of the spleen with a torn hilar vessel.

Other types of splenic injury are fragmentations with avulsion of lower or upper pole, longitudinal or stellate lacerations and subcapsular hematomas.

Bleeding at surgery is active only in injuries extending deep in hilum. Ferquent absence of active bleeding at the time of opearation and the anatomical configuaritve of the spleen make the management of splenic injury possible either nonoperatively or by spleen-saving operative procedures. This concept has been established as a common practice in Pediatric Surgery after the recognition that overwhelming sepsis may occur in splenectomized individuals.

Immunalogical properties of the spleen

The spleen represents approximately 25% of the lymphoid tissue [21]. Its importance in resistance to infection was first recorded in 1919 as an experimental conclusion [24]. Five infants with fatal sepsis after splenectomy for hematologic disorders were reported by King and Schumacker in 1952 [20]. All were infants, and patients reported in 1958 and 1967 were almost all under 5 yr of age [16,12]. In the 1970's however, trauma related postsplenectomy cases of sepsis were reported with increasing frequency [2,32]. It is now well recognized that trauma related asplenic children have an incidence of malignant sepsis 85 times higher than the rate in the normal population. Postsplenectomy sepsis may occur at any time postopeartively. The risk is greatest in the first 2-3 years after the operation and occurence is more frequent in children aged under 5 years. Postsplenectomy sepsis develops rapidly with refractory intravascular coagulopathy and death within 24 hours. 1,5% of the patients following trauma-related splenectomy are affected and the mortality rate is 50% [11]. It is well known that the spleen is actively incolved in the immune system with three main functions: trapping of particulate antigens, antibody production, and phagocytosis. The major postoplenectomy changes in the immune system are the following: a) failure of filtration and clearance of pitted cells and Howell-Jolly inclusion bodies, b) low serum IgM levels, c) decrease in the number and function of T and B lymphocytes, d) decrease in properdin levels and opsonic activity, e) decrease in phagocytosis promoting tuftsin, f) decrease in complement levels [31,8,6,2,38].

The most common organisms causing fatal sepsis are pneumococci. Other organisms including meningococcus, H. influenzae, enterobacter, group A steptococcus, and staphylococcus aureus have also been implicated [17]. Certain precautions

have been established to guard against postsplenectomy sepsis. These are the immunization with polyvalent pneumococcal vaccine (pneumovax) and the administration of penicillin on a longterm basis. The letter is effective against some of the oranisms associated with postsplenectomy sepsis. It must be noted that immunization does not protect against infections for all pneumococcal seral types [1].

Modes of treatment of splenic injury

The importance of retaining the function of the traumatized spleen has received universal acceptance. About 90% of the cases can be treated nonoperatively. The majority of remaining cases are managed with spleen saving operative procedures. These include splenorrhapy, ligation of the splenic artery as an adjunct to splenorrhaphy, and autotrasplantation of splenic tissue in cases of maceration of these tissue adhesives such as activated microcrystallin collagen and special modern techniques for resecting the damaged splenic tissue could be added. The latter include ultrasonic splenectomy, microwave techniques, cryogenic surgery, heat coagulation etc. [4].

Nonoperative management is indicated if the patient a) maintains stable vital signs, b) requires less than half of blood volume replacement, c) is free of concomitant intraabdominal injuries, d) is free of severe multiple injuries. The patient must be constantly monitored in an intensive care unit. Douglas and Simpson pioneered conservative management of splenic injuries in the year 1979 [10].

Splenorrhaphy is effective in all injuries not involving major segmental vessels. It was first practiced by Mazel in 1945 but his work was ignored [22]. In 1974, Mishalany reported eight cases of splenic repair by suture [23]. Suturing proper splenic parenchyma is not possible. However, the flow pressure within the sinusoids allows control of bleeding by placing capsular sutures and reducing arterial inflow. A horizontal mattress of figure-eight suture with 2-0 or 3-0 chromic cat-gut or vicryl is the standard techique. An omental patch is useful to reinforce the repair. We do not practice extensive mobilization of the spleen into the operative field, in order to spare the splenic attachments and potential collateral circulation.

The first observations and results with splenic artery ligation were published by Sherman and Asch and by Keramidas respectively at the end of the last decade [33,17]. The effects of this procedure on the injured spleen and its function were studied previously in experimental animals [18]. During the period 1977-1988, twenty eight children were submitted to splenic artery ligation in pediatric surgical units of Athens. Profuse bleeding was thus controlled in all the cases. Follow up, including radioscintigraphies and immunologic studies demonstrated normal splenic function up to ten years postopearitvely. This maneuver may be employed in instances of hilar injuries, in type-III or IV injuries i.e. fragmentations extending up to the hilum, and in avulsions of splenic mass with profuse bleeding. Resection of an avulsed lower pole can be safely done following the ligation of the splenic artery. If the avulsed upper is excised, viability of the inferior should be assessed to exclude possible isolation from the collateral circulation by the traumatic lesion. Post-ligation arteriographies of the first cases of our series demonstrated that revascularization of the spleen develops rapidly and its pattern is rather uniform. Ingrowing collaterals derive mainly from the short gastric arteries and by pericapsular arterial invasion [19]. Besides, possible recanalization of the splenic artery could be accomplished if absorbable material is used for the ligation. Several authors have added their experience with splenic artery ligation as a spleen saving procedure [7,14,13,4].

Splenectomy and heterotopic autotransplantation of splenic tissue was first practiced by Benjamin et al in 1978 [3]. This procedure was succesfully used for saving splenic tissue [29,36,37,25,4]. But other investigators have shown the failure of splenic implants against post-splenectomy sepsis [30,26,34,28]. Fatal outcome has been reported although up to 92 gr of splenic tissue was found at autopsy [27]. Altered vascularity and scarring in splenic regenerates has been implicated [15]. It is

obvious that immunological functions of the spleen are better safeguarded when preserving as big a splenic mass as possible. This can be accomplished only by splenorrhaphy and/or the ligation of the splenic artery. Heterotopic autotransplantation of splenic tissue should be reserved for the treatment of maceration of the spleen with total separation from its blood supply.

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