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doi:10.3748/wjg.14.6711

World J Gastroenterol 2008 November 21; 14(43): 6711-6716
World Journal of Gastroenterology ISSN 1007-9327

RAPID COMMUNICATION

Non-traumatic splenic rupture: Report of seven cases and review of the literature

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Received: May 18, 2008 Revised: July 6, 2008
Accepted: July 13, 2008
Published online: November 21, 2008

Abstract

AIM: To evaluate seven patients with non-traumatic splenic rupture (NSR). NSR is an uncommon dramatic abdominal emergency that requires immediate diagnosis and prompt surgical treatment to ensure the patient's survival.

METHODS: Within 11 years, seven cases were evaluated for patient characteristics, anamnesis and symptoms, method of diagnosis, findings of laparotomy, and etiology of NSR.

RESULTS: There were six (86%) male and one female (14%) patient, whose mean age was 36 ± 12.8 (17-56) years. We report here four cases of *Plasmodium vivax* malaria (cases Ⅰ-Ⅳ), one case of hemodialysis (case Ⅴ), one case of spontaneous splenic rupture (case Ⅵ), and one case of hairy cell leukemia (case Ⅶ). Splenectomy was performed in all patients. All of them made an uneventful recovery and were discharged in stable condition.

CONCLUSION: NSR is a rare entity that needs a high index of suspicion for diagnosis. Using ultrasonography or computer tomography, and peritoneal aspiration of fresh blood may assist in the diagnosis of NSR. Increased awareness of NSR can enhance early diagnosis and effective treatment.

Key words: Hairy cell leukemia; Hemodialysis; Malaria; Splenic rupture

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Gedik E, Girgin S, Aldemir M, Keles C, Tuncer MC, Aktas A. Non-traumatic splenic rupture: Report of seven cases and review of the literature. *World J Gastroenterol* 2008; 14(43): 6711-6716 Available from: URL: http://www.wjgnet.com/1007-9327/14/6711.asp DOI: http://dx.doi.org/10.3748/wjg.14.6711

INTRODUCTION

Trauma is the most common cause of splenic rupture, while non-traumatic splenic rupture (NSR) is a rare condition. NSR has been described in the medical literature as a clinical oddity with grave consequences, if unrecognized and untreated[1]. NSR rarely occurs in a histologically proven normal spleen, and in such cases, is called a spontaneous rupture. NSR usually occurs in a diseased spleen and is called a pathologic rupture[2]. Infection, malignancy, metabolic disorders, as well as vascular and hematological diseases, of which only single case reports have been published in the literature, are the usual reasons[3-5]. Recently, some authors have reported that spontaneous splenic rupture has been seen as a factor in malaria[6,7], aortic valve replacement for bacterial endocarditis[8], normal spleen[9], factor Ⅷ deficiency, which is a rare autosomal bleeding disorder with a frequency of 1:2 000 000 in the general population[10], and autologous transplantation for primary systemic amyloidosis[11]. Especially, malaria was discussed retrospectively in all aspects by authors. It has been reported that the disease has started spreading from its hotspots to new areas, including many parts of the United States and southern Europe, including Azerbaijan and Turkey[12]. We report here seven cases with NSR, who were successfully treated by splenectomy.

MATERIALS AND METHODS

The medical records of seven patients with NSR, who

Table 1 Patient characteristics

Cause of NSR	Age/sex	TA (mmHg)	Splenic weight (g)	Diagnosis		Observation time (h)	Amount of free blood (cc)	Grade of splenic injury	Amount of blood transfusion (U)	Duration of hospitalization (d)
				Parasynthesis	Radiological imaging					
Malaria (Case Ⅰ)	56/M	80/60	950	+	USG	4	1500	Ⅲ	3	6
Malaria (Case Ⅱ)	32/M	70/40	1050	+	None	Urgent Laparotomy	1200	Ⅱ	2	11
Malaria (Case Ⅲ)	46/M	90/60	800	+	USG	6	1700	Ⅲ	2	5
Malaria (Case Ⅳ)	17/M	80/50	980	+	USG	5	1500	Ⅲ	5	4
Hemodialysis patient (Case Ⅴ)	29/M	80/40	220	+	USG	3	1500	Ⅲ	3	5
Spontaneous (Case Ⅵ)	30/M	120/70	195	+	USG/CT	18	2000	Ⅱ	6	5
Hairy Cell Leukemia (Case Ⅶ)	42/F	65/40	2540	+	None	Urgent Laparotomy	2500	Ⅲ	5	15

NSR: Nontraumatic splenic rupture; TA: Tension arterial; USG: Ultrasonography; CT: Computerized tomography.

were treated in the Department of General Surgery, Dicle University Hospital, between 1995 and 2006, were reviewed retrospectively. The patients did not have a minor or trivial trauma history before admission. Standard advanced trauma life support resuscitation protocols were used in all patients. All patients received preoperative antibiotics and were maintained on antibiotics for at least 24 h postoperatively. Splenic injury grade was defined in accordance with the Organ Injury Scaling Committee of the American Association of Surgery for Trauma (AAST)[13]. After splenectomy, Pneumovax and *Haemophilus influenzae* vaccines were given. Histopathological analysis of masses was performed.

Patient data were evaluated for their characteristics (Table 1), anamnesis and symptoms, method of diagnosis, findings of laparotomy, and etiology of NSR. The constant variables were expressed as mean ± SD, except where otherwise stated.

RESULTS

Cases I -IV

We determined that NSR was due to malaria in four patients. The mean age of these patients was 37.7 ± 8.48 (17-56) years, and all of them were male. Our area is endemic for malaria, and before patients presented to our hospital, they had been diagnosed as malaria by the Free Malaria Out-Patient Clinic, which treats for free patients who have been taking antimalarial therapy. Trophozoites and schizonts of *Plasmodium vivax* were identified in peripheral blood smears to confirm previous diagnoses in all patients in our institute. No patient had a history of glucose-6-phosphate dehydrogenase deficiency. The abdominal ultrasound scans of three patients showed an enlarged, ruptured spleen and intraperitoneal free blood. Gross examination revealed grayish-brown or dark grey discolored spleen with capsular tears. Microscopy revealed congestion and dilatation of sinusoids, mononuclear infiltration with focal necrosis in capillaries and splenic pulp. Mean hospitalization time of patients who had splenic rupture with malaria etiology was 6.50 ± 1.55 (4-11) d. The patient who was hospitalized for the longest period of 11 d was receiving treatment for duodenal ulcer in the gastroenterology department. He immediately became hypotensive, and had abdominal pain on the day 4 of hospitalization. We performed abdominal parasynthesis, which demonstrated free blood in the peritoneal cavity. Since he was in shock, he underwent explorative laparotomy, and splenectomy was performed. The patient had postoperative wound infection on day 5, and he was discharged on day 11 after therapy.

Case V

A 29-year-old male hemodialysis patient was admitted to our emergency department. Severe left upper abdominal pain developed 2 d prior to admission. He had a history of hypertension and urolithiasis for 6 years, and he was undergoing hemodialysis twice weekly. Abdominal ultrasonography revealed a hyperechogenic mass that was composed of spleen and perisplenic fluid, and another mass, which showed internal echogenicity. A moderate amount of free fluid was present in the pelvic abdomen (Figure 1). Gross examination showed a dark gray spleen, which weighed 220 g, with capsular tears and subcapsular hematoma on the medial side. Microscopy revealed sinus dilatation, and increased fibrous tissue and hemosiderin pigments. The postoperative course was uneventful, and the patient was discharged from hospital on day 5.

Case VI

A healthy 30-year-old man was admitted to the emergency department previously with complaints of abdominal pain. His pain began approximately 3 h before arrival, which he described as being vague periumblical pain. He had no recent illness or trauma and no medical or surgery history. Initially, pain was minimal and he had no peritoneal signs, and his abdomen was non-distended, with normal bowel sounds. He had epigastric and left upper quadrant tenderness with voluntary guarding in this region. He denied taking any drugs, and did not have any symptoms and signs such as nausea, vomiting, diarrhea, melena, hematochezia, cough,

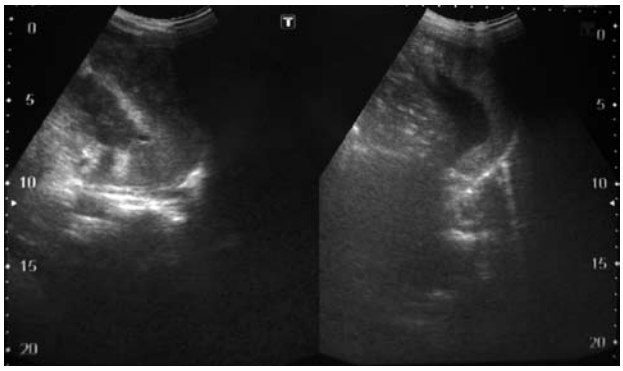

Figure 1 Abdominal ultrasonography of case Ⅴ revealed a hyperechogenic mass composed of spleen and perisplenic fluid.

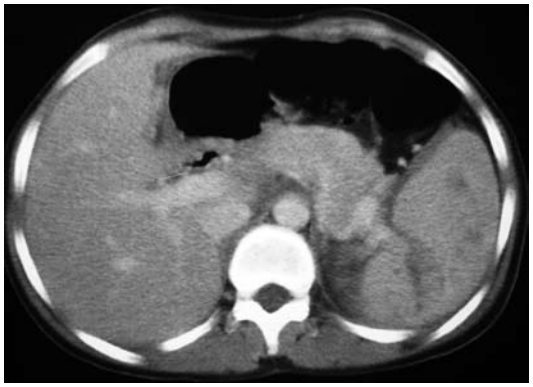

Figure 2 CT of case Ⅵ revealed massive hemoperitoneum and large tears of the splenic hilus.

shortness of breath, weight loss, or fever. Heart and lung examination was normal. The genitourinary examination was normal, without hernia. Abdominal parasynthesis was performed, and free blood in the peritoneal cavity was observed. Abdominal ultrasonography showed perisplenic and left paracolic free fluid. Furthermore, computerized tomography (CT) showed massive hemoperitoneum and large tears of the splenic hilus (Figure 2). In spite of non-operative management at 18 h after arrival at the emergency department, he became hemodynamically unstable and had to be taken to the operating room for emergency surgery. Exploratory laparotomy was performed. After opening of the abdomen, 2000 mL of blood was removed immediately. The spleen was removed without complication and was sent for pathological investigation. The pathology report demonstrated the spleen to be of normal size. The rupture was found in medial side, penetrating into the parenchyma of the spleen. Paired acute-phase and convalescent sera provided no evidence of acute viral infection, and cultures from blood, sputum, stool and urine were negative. Screening for autoantibodies was negative. The patient's hospital course was uneventful, and he was discharged on postoperative day 5.

Case Ⅶ

A 42-year-old woman was admitted to our hospital with a history of weakness, easy fatigability, weight loss, and left upper abdominal pain for one month. After splenomegaly was determined, the patient was hospitalized in our department for etiological investigation. After one day of hospitalization, she developed sudden hypotension, tachycardia, and generalized abdominal pain. There was abdominal distension and peritoneal irritation upon physical examination. We performed abdominal parasynthesis, which demonstrated free blood in the peritoneal cavity. Laparotomy showed extensive hemoperitoneum and markedly enlarged spleen, with areas in which it appeared to be a tumor pushing through the splenic capsule, which was torn and bleeding excessively. Microscopic examination of the spleen revealed that splenic sinuses and cords (Figure 3A) were surrounded by hairy cells in the expanded red pulp (Figure 3B). The patient had a complication of pneumonia on postoperative day 5, which was managed successfully with antibiotic therapy; she made an uneventful recovery and was discharged in stable condition after 15 d.

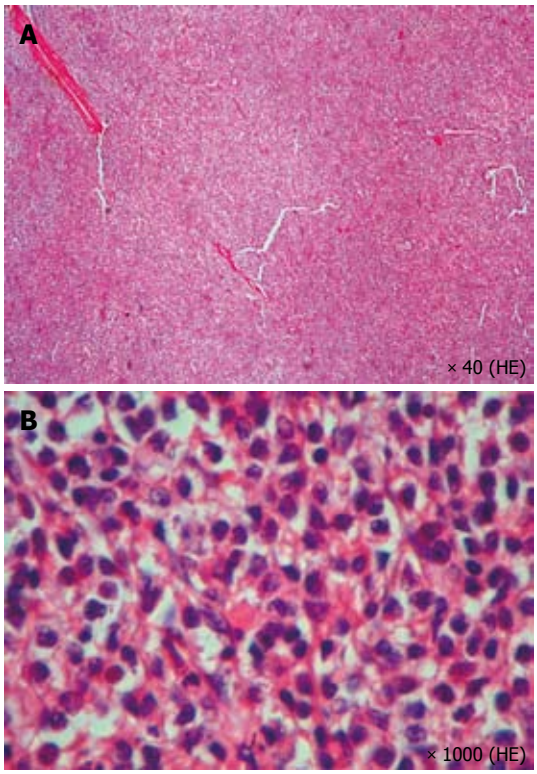

Figure 3 HE staining reveals splenic sinuses and cords of case Ⅶ (A, x 40) surrounded by hairy cells in the expanded red pulp (B, x 1000).

DISCUSSION

NSR may occur in 0.1%-0.5% of patients with no associated trauma[14]. The first cases of spontaneous splenic rupture were reported by Rokitansky[15] in 1861 and Atkinson[16] in 1874.

The actual reason for the rupture is not yet fully understood, although the size of the organ plays a significant role. However, normal-sized organs have been reported with ruptured spleen[17]. Three mechanisms have been implicated in the process. The first of these

mechanisms is increased intrasplenic tension that is caused by cellular hyperplasia and engorgement. The second is that the spleen may be compressed by the abdominal musculature during physiological activities, such as sneezing, coughing and defecation. Finally, vascular occlusion caused by reticular endothelial hyperplasia, which results in thrombosis and infarction, may be involved. This leads to interstitial and subcapsular hemorrhage and stripping of the capsule, which causes further subcapsular hemorrhage. The distended capsule finally gives way[18,19]. A Medline search for cases of NSR revealed that 454 cases were reported between 1966 and February 2007[20,21].

Malaria is the most common cause of pathologic rupture of spleen in the tropics, and life-threatening complications occur in up to an estimated 2% of cases[6,7,12,20,22]. Most cases of pathologic rupture of the spleen in malaria occur during acute infection, and usually during the primary attack[23]. Chronically enlarged spleens are less vulnerable to rupture[20]. When a palpable spleen is present, it is generally recognized within 3-4 d of the onset of symptoms. If the disease goes untreated, the spleen may grow and result in greater average spleen size, as the prevalence of malaria increases[24]. This occurrence is likely caused by rapid hyperplasia and stretching of splenic parenchyma and capsule, a high frequency of small infarctions, hemorrhage and tears, a lack of extensive connective tissue and fibrosis (as found in chronic malarial spleens); an increased risk of minor stress to the spleen (e.g. vomiting, rigors) and a lack of prior immunity[23]. Spontaneous splenic rupture is more common with *P. vivax* than *Plasmodium falciparum* malaria. In Turkey, *P. vivax* is the predominant *Plasmodium* species (99.9%)[18,25]. In all our patients, *P. vivax* was present with pathologic splenic rupture. Patients were experiencing primary attacks of malaria and were in the acute stage of the disease.

Spontaneous rupture of the spleen is extremely rare[2,26-28]. According to Orloff and Peksin[29], a small group of cases exist, in which the only justifiable conclusion is that the spleen ruptures spontaneously without known cause. They identified four criteria for the diagnosis of spontaneous splenic rupture: (1) on thorough questioning, either prior to operation or in retrospect after operation, there should be no history of trauma or unusual activity that could conceivably injure the spleen; (2) there should be no evidence of disease in other organs that are known to affect the spleen adversely and thereby could cause it to rupture; (3) there should be no evidence of perisplenic adhesions or scarring of the spleen that suggests it has been traumatized or ruptured previously; (4) without findings of hemorrhage and rupture, the spleen should be normal on both gross inspection and histological examination. Crate *et al*[30] added a fifth criterion: studies of acute-phase and convalescent sera should not show any significant rise in viral antibody titers that are suggestive of recent infection with viruses associated with splenic involvement. The patient, who was accepted with spontaneous splenic rupture, had these five criteria. The pathophysiology of spontaneous splenic rupture is obscure. It should be considered that undetected structural abnormalities in spleen may cause NSR.

Pathological rupture of the spleen is most commonly seen in the hematological malignancies[31], in which fragmentation and dissolution of the fibrous capsule of the spleen occur by infiltrating atypical lymphocytes, as seen in lymphoma or leukemia[20]. Giagounidis *et al*[32] have reported that male sex, adulthood, severe splenomegaly and cytoreductive chemotherapy are factors that are associated more often with rupture of the spleen in hematological malignancies. The most common finding was splenomegaly, which was present in 96% of patients with hairy cell leukemia[33]. One of the patients with pathological splenic rupture had hairy cell leukemia, with marked splenomegaly. In patients with hematological malignancy, pathological rupture of the spleen often happens unexpectedly, without preceding trauma[34]. Therefore, diagnosis is often difficult, and diagnosis of splenic rupture must be considered in all patients with hematologic malignancies. Acute or subacute new abdominal pain, hypotension and tachycardia, even if there is no previous history of trauma, must be treated aggressively.

Dialysis patients with chronic renal failure (CRF) show a fibrinolysis defect at the level of plasminogen activation. Reduced fibrinolysis may be responsible, along with other factors, for development of thrombosis, atherosclerosis and their complications[35]. Abnormal homeostasis is also common in CRF and is characterized by a tendency to abnormal bleeding and bruising. Prolongation of bleeding time, decreased activity of platelet factor Ⅲ, abnormal platelet aggregation and adhesiveness, and impaired prothrombin consumption contribute to the clotting defects. Besides, edema of the spleen and formation of a subcapsular hematoma (secondary to uremic coagulopathy and use of heparin in those who are on hemodialysis) may occur in uremia[36]. Fluid overload is the major cause of hypertension in uremia; the normotensive state usually can be restored by aggressive ultrafiltration with dialysis. Nevertheless, because of hyper-reninemia, in spite of rigorous salt and water restriction and ultrafiltration, some patients maintain hypertension[37]. We detected hypertension in our patients. The underlying cause for the NSR may be uremic coagulopathy and hypertension.

The most common symptom is left upper quadrant abdominal pain. This pain can become generalized, with distention, tenderness and rigidity in later stages. The abdominal symptoms may be accompanied by pallor, tachycardia, hypotension and oliguria. Eventually, more than half of patients will suffer hemorrhagic shock if the condition is left untreated[27,38]. Diagnosis is based on clinical symptoms and confirmatory diagnostic tests. Some authors have reported that paracentesis is the most effective diagnostic procedure[4,39]. Abdominal ultrasound is an inexpensive and practical way to obtain a quick diagnosis of intraperitoneal fluid accumulation or hematoma, which can be performed at the patient's bedside or in the emergency unit[28]. CT signs of NSR may be useful for predicting rupture, and clearly show

grade of splenic damage severity and intraperitoneal free fluid[2]. We think that abdominal ultrasound can be a good, non-invasive technique, without risk for the patients who are hemodynamically unstable, whereas CT can be useful for patients who are hemodynamically stable. Paracentesis is not only useful in NSR, but also in patients in whom we think there is intraperitoneal hemorrhage and who are unstable. Negative results of paracentesis are not certain to show that there is no hemorrhage, but a positive result indicates the possibility of intraperitoneal hemorrhage. In fact, if paracentesis is positive, it leads us to consider the possibility of intra-abdominal hemorrhage.

The management of spontaneous or pathological splenic hemorrhage has been debated constantly. Among 136 cases of pathological splenic rupture reported in the literature, 88 underwent surgical intervention, 55 (63%) survived and 33 (37%) died. Among 43 patients who did not undergo surgery, 40 died. No information could be obtained for the five remaining cases[32]. Aggressive management with early surgical intervention and appropriate hemoderivative support is important[40]. The survival of patients following splenectomy is probably well correlated with the course of the underlying disease. The trauma literature is replete with data supporting the role of non-operative management of low-grade splenic injuries in hemodynamically stable patients[41,42]. The same principle has been applied for the management of spontaneous splenic rupture[43]. In our series, since six patients were hemodynamically unstable, after rapid fluid and blood infusions, the patients underwent splenectomy. One patient, who had SRS, and was hemodynamically stable at admission, to avoid the risks of splenectomy, was given medical therapy at first, but after 18 h, the patient became unstable; therefore, splenectomy was performed. One patient developed wound infection and another pneumonia, but all patients were discharged uneventfully.

In conclusion, NSR is a rare entity that needs a high index of suspicion for diagnosis. Absence of a history of trauma can make it difficult to reach a diagnosis, which causes delay in treatment. Using ultrasonography or CT, and peritoneal aspiration of fresh blood may assist in the diagnosis of NSR. Rapid diagnosis, aggressive resuscitation, and surgical intervention can lead to a successful outcome in patients with NSR.

COMMENTS

Background

NSR is a rare condition in emergency surgery. NSR may be seen along with different diseases, such as malaria, infections, malignancies, metabolic disorders, as well as vascular and hematological diseases. Also, spontaneous rupture of the spleen may be observed. Absence history of a trauma may not remind a rupture needs a high index of suspicion for diagnosis in spleen.

Research frontiers

The criteria for NSR were first described by Orloff *et al* in 1958 and our patients with NSR were in accordance with these criteria.

Innovations and breakthroughs

Our study emphasized that rapid diagnosis, aggressive resuscitation, and surgical intervention are important for successful outcome in patients with NSR. If the patient with intra-abdominal hemorrhage has no associated trauma, splenic rupture should be considered.

Applications

NSR may be shown in particular in endemic regions of malaria, hematological malignancies, and spontaneous and chronic renal failure.

Peer review

In this study, NSR was presented with different diseases. Diagnosis of NSR, using ultrasonography or CT, and paracentesis, is difficult. Splenectomy may lead to a successful outcome in patients with NSR.

REFERENCES

1 **Hyun BH**, Varga CF, Rubin RJ. Spontaneous and pathologic rupture of the spleen. *Arch Surg* 1972; **104**: 652-657
2 **Torricelli P**, Coriani C, Marchetti M, Rossi A, Manenti A. Spontaneous rupture of the spleen: report of two cases. *Abdom Imaging* 2001; **26**: 290-293
3 **Andrews DF**, Hernandez R, Grafton W, Williams DM. Pathologic rupture of the spleen in non-Hodgkin's lymphoma. *Arch Intern Med* 1980; **140**: 119-120
4 **Bauer TW**, Haskins GE, Armitage JO. Splenic rupture in patients with hematologic malignancies. *Cancer* 1981; **48**: 2729-2733
5 **Gallerani M**, Vanini A, Salmi R, Bertusi M. Spontaneous rupture of the spleen. *Am J Emerg Med* 1996; **14**: 333-334
6 **Jimenez BC**, Navarro M, Huerga H, Lopez-Velez R. Spontaneous splenic rupture due to Plasmodium vivax in a traveler: case report and review. *J Travel Med* 2007; **14**: 188-191
7 **Tauro LF**, Maroli R, D'Souza CR, Hegde BR, Shetty SR, Shenoy D. Spontaneous rupture of the malarial spleen. *Saudi J Gastroenterol* 2007; **13**: 163-167
8 **Dimitrakakis G**, Von Oppell U, Zilidis G, Srivastava A. Splenic rupture complicating aortic valve replacement for bacterial endocarditis. *Interact Cardiovasc Thorac Surg* 2008; **7**: 138-140
9 **Vahid B**, Bosanac A, Marik P. Spontaneous rupture of the normal spleen: a case report. Priory Medical Journals, Surgery On-line, 2005-10-8. Available from: URL: http://www.priory.com/surgery/spleen.pdf
10 **Khalife H**, Muwakkit S, Al-Moussawi H, Dabbous I, Khoury R, Peyvandi F, Abboud MR. Spontaneous splenic rupture in a patient with factor XIII deficiency and a novel mutation. *Pediatr Blood Cancer* 2008; **50**: 113-114
11 **Fernandez de Larrea C**, Cibeira MT, Rovira M, Rosinol L, Esteve J, Blade J. Spontaneous rupture of the spleen as immediate complication in autologous transplantation for primary systemic amyloidosis. *Eur J Haematol* 2008; **80**: 182-184
12 **Ramana B**. Malaria: who is at fault? *World J Surg* 2007; **31**: 2072-2074
13 **Moore EE**, Shackford SR, Pachter HL, McAninch JW, Browner BD, Champion HR, Flint LM, Gennarelli TA, Malangoni MA, Ramenofsky ML. Organ injury scaling: spleen, liver, and kidney. *J Trauma* 1989; **29**: 1664-1666
14 **Lai PK**. Infectious mononucleosis: recognition and management. *Hosp Pract* 1977; **12**: 47-52
15 **Laseter T**, McReynolds T. Spontaneous splenic rupture. *Mil Med* 2004; **169**: 673-674
16 **Badenoch DF**, Maurice HD, Gilmore OJ. Spontaneous rupture of a normal spleen. *J R Coll Surg Edinb* 1985; **30**: 326-327
17 **Zieren J**, Paul M, Scharfenberg M, Muller JM. The spontaneous splenic rupture as first manifestation of mantle cell lymphoma, a dangerous rarity. *Am J Emerg Med* 2004; **22**: 629-631
18 **Yagmur Y**, Kara IH, Aldemir M, Buyukbayram H, Tacyildiz IH, Keles C. Spontaneous rupture of malarial spleen: two case reports and review of literature. *Crit Care* 2000; **4**: 309-313
19 **Patel MI**. Spontaneous rupture of a malarial spleen. *Med J Aust* 1993; **159**: 836-837

20 **Debnath D**, Valerio D. Atraumatic rupture of the spleen in adults. *J R Coll Surg Edinb* 2002; **47**: 437-445
21 **Tataria M**, Dicker RA, Melcher M, Spain DA, Brundage SI. Spontaneous splenic rupture: the masquerade of minor trauma. *J Trauma* 2005; **59**: 1228-1230
22 **Ozsoy MF**, Oncul O, Pekkafali Z, Pahsa A, Yenen OS. Splenic complications in malaria: report of two cases from Turkey. *J Med Microbiol* 2004; **53**: 1255-1258
23 **Zingman BS**, Viner BL. Splenic complications in malaria: case report and review. *Clin Infect Dis* 1993; **16**: 223-232
24 **Russel PF**, West LS, Manwell RD, Macdonald G. Practical Malariology. 2nd ed. London: Oxford University Press, 1963: 371-485
25 **Akdur R**. Epidemiology of malaria [in Turkish]. In: Ozcel MA. Sitma, Malaria. Izmir: Ege Universitesi Basimevi, 1999: 51-118
26 **Tu AS**, Tran MHT, Larsen CR. Spontaneous splenic rupure: report of five cases and a review of the literature. *Emerg Radiol* 1997; **4**: 415-418
27 **Denehy T**, McGrath EW, Breen JL. Splenic torsion and rupture in pregnancy. *Obstet Gynecol Surv* 1988; **43**: 123-131
28 **Klinkert P**, Kluit AB, de Vries AC, Puylaert JB. Spontaneous rupture of the spleen: role of ultrasound in diagnosis, treatment, and monitoring. *Eur J Surg* 1999; **165**: 712-713
29 **Orloff MJ**, Peksin GW. Spontaneous rupture of the normal spleen; a surgical enigma. *Int Abstr Surg* 1958; **106**: 1-11
30 **Crate ID**, Payne MJ. Is the diagnosis of spontaneous rupture of a normal spleen valid? *J R Army Med Corps* 1991; **137**: 50-51
31 **Oinonen R**, Franssila K, Elonen E. Spontaneous splenic rupture in two patients with a blastoid variant of mantle cell lymphoma. *Ann Hematol* 1997; **74**: 33-35
32 **Giagounidis AA**, Burk M, Meckenstock G, Koch AJ, Schneider W. Pathologic rupture of the spleen in hematologic malignancies: two additional cases. *Ann Hematol* 1996; **73**: 297-302
33 **Hoffman MA**. Clinical presentations and complications of hairy cell leukemia. *Hematol Oncol Clin North Am* 2006; **20**: 1065-1073
34 **Biswas S**, Keddington J, McClanathan J. Large B-cell lymphoma presenting as acute abdominal pain and spontaneous splenic rupture; a case report and review of relevant literature. *World J Emerg Surg* 2006; **1**: 35
35 **Opatrny K Jr**. Hemostasis disorders in chronic renal failure. *Kidney Int Suppl* 1997; **62**: S87-S89
36 **Zbrog Z**, Pawlicki L. [Spontaneous rupture of the spleen as a cause of death of a patient with uremia] *Pol Tyg Lek* 1989; **44**: 232-233
37 **Lazarus JM**, Brenner BM. Chronic renal failure. In: Fauci AS, Braunwald E, Isselbacher KJ, Wilson JD, Martin JB, Kasper DL, Hauser SL, Longo DL. Harrison's Principles of Internal Medicine. 14th ed. USA: The McGraw-Hill, 1998: 1513-1520
38 **Toubia NT**, Tawk MM, Potts RM, Kinasewitz GT. Cough and spontaneous rupture of a normal spleen. *Chest* 2005; **128**: 1884-1886
39 **Altes A**, Brunet S, Martinez C, Soler J, Ayats R, Sureda A, Lopez R, Domingo A. Spontaneous splenic rupture as the initial manifestation of acute lymphoblastic leukaemia: immunophenotype and cytogenetics. *Ann Hematol* 1994; **68**: 143-144
40 **Bernat S**, Garcia Boyero R, Guinot M, Lopez F, Gozalbo T, Canigral G. Pathologic rupture of the spleen as the initial manifestation in acute lymphoblastic leukemia. *Haematologica* 1998; **83**: 760-761
41 **King DR**, Lobe TE, Haase GM, Boles ET Jr. Selective management of injured spleen. *Surgery* 1981; **90**: 677-682
42 **Smith JS Jr**, Wengrovitz MA, DeLong BS. Prospective validation of criteria, including age, for safe, nonsurgical management of the ruptured spleen. *J Trauma* 1992; **33**: 363-368; discussion 368-369
43 **Brichkov I**, Cummings L, Fazylov R, Horovitz JH. Nonoperative management of spontaneous splenic rupture in infectious mononucleosis: the role for emerging diagnostic and treatment modalities. *Am Surg* 2006; **72**: 401-404

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