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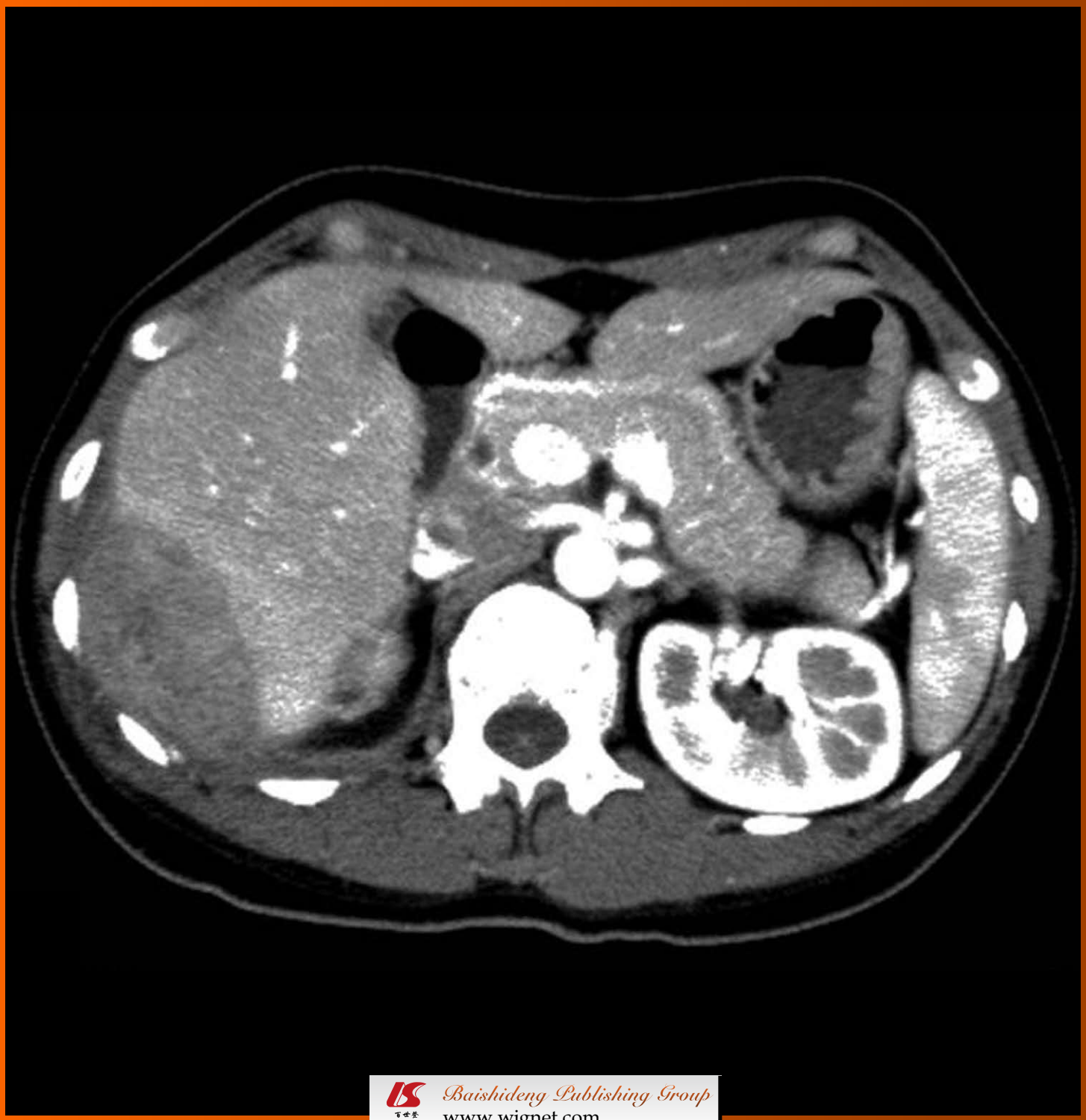

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EDITORIAL

Small for size syndrome following living donor and split liver transplantation

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Abstract

The field of liver transplantation is limited by the availability of donor organs. The use of living donor and split cadaveric grafts is one potential method of expanding the donor pool. However, primary graft dysfunction can result from the use of partial livers despite the absence of other causes such as vascular obstruction or sepsis. This increasingly recognised phenomenon is termed "Small-for-size syndrome" (SFSS). Studies in animal models and humans have suggested portal hyperperfusion of the graft combined with poor venous outflow and reduced arterial flow might cause sinusoidal congestion and endothelial dysfunction. Graft related factors such as graft to recipient body weight ratio < 0.8, impaired venous outflow, steatosis > 30% and prolonged warm/cold ischemia time are positively predictive of SFSS. Donor related factors include deranged liver function tests and prolonged intensive care unit stay greater than five days. Child-Pugh grade C recipients are at relatively greater risk of developing SFSS. Surgical approaches to prevent SFSS fall into two categories: those targeting portal hyperperfusion by reducing inflow to the graft, including splenic artery modulation and portacaval shunts; and those aiming to relieve parenchymal congestion. This review aims to examine the controversial diagnosis of SFSS, including current strategies to predict and prevent its occurrence. We will also consider whether such interventions could jeopardize the graft by compromising regeneration.

Key words: Liver transplantation; Living donors; Hypertension; Portal; Splenic artery; Liver regeneration; Hepatic veins; Portacaval shunt; Surgical

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INTRODUCTION

From the beginning, transplant surgery has always been limited by organ availability. Split cadaveric and living donor grafts have gained popularity in the past twenty years as initial technical hurdles were overcome. From 1988 to 2008 a total of 4103 split cadaveric and 3079 living donor transplantations were carried out in Europe[1] and over 75% of these have taken place in adult-to-adult cases. This practice has generated a phenomenon known as "Small-for-size-syndrome" (SFSS), where a small graft exhibits primary dysfunction. The name is misleading; the graft need not necessarily be small if it is steatotic or if the recipient has adverse risk factors such as existing portal hypertension and Child-Pugh grade C. This review explores the putative mechanism underlying SFSS, risk factors, prevention and treatments.

PATHOPHYSIOLOGY OF "SMALL-FOR-SIZE SYNDROME"

SFSS has become increasingly recognised in the last 20 years since partial liver grafts made the leap from paediatric to adult transplantation. SFSS in orthotopic liver transplantation describes a condition in which a small graft (graft to recipient weight ratio < 0.8) exhibits signs of primary graft dysfunction within the first post operative week in the absence of other diagnoses such as vascular obstruction, biliary leak, sepsis and immune rejection[2]. Coagulopathy, ascites and hyperbilirubinemia are typical manifestations. This definition derives from a survey of 20 expert partial liver transplant surgeons across the world[2]. Whilst all 20 consider SFSS to be a distinct clinical entity, opinion on its underlying pathological basis is very much divided. Most of them consider that portal hyperperfusion forms part of the syndrome but less consensus was obtained about the importance of the role played by outflow obstruction.

Portal hyperperfusion, venous congestion and arterial hypoperfusion, as well as simple insufficiency of liver mass, have all been suggested as contributory mechanisms for pathogenesis. Several case series of living donor liver transplants[3,4] have shown significant elevation of portal venous pressure in small grafts [graft weight to recipient body weight ratio (GWRW) < 0.8]. Differentially elevated portal venous pressure (PVP) in small grafts persisted for as long as fourteen days post operatively compared to non-SFSS grafts[5]. This is clinically significant as PVP > 20 mmHg is correlated with poorer graft survival (38% *vs* 85%) at six months[6].

Recently, rat, mouse and porcine models have given valuable insight into SFSS under controlled conditions[7-9]. A porcine model where recipients were transplanted with 19.3%-25.3% standard liver volume showed significant increases in portal venous flow, portal pressure and vascular resistance, along with reduced arterial flow. In addition, markers of endothelial and hepatocyte injury were markedly elevated compared to the whole graft group[8]. Another porcine model using a range of liver graft sizes demonstrated typical histopathology of SFSS. Congestion, hemorrhage, sinusoidal/endothelial damage, septal edema and architectural disruption can be seen as soon as five minutes post reperfusion and persist for up to five days post operatively in small 20%-30% grafts. These histological changes were more severe and prolonged in the smaller grafts[9]. These findings correlate with a human study showing sinusoidal endothelial disruption and focal hemorrhage dissecting into connective tissue, along with hepatic artery spasm[10]. However, regeneration rate was also markedly increased in SFSS grafts, a common theme across both human and animal studies, suggesting a degree of portal hyperperfusion may be necessary to induce liver regeneration. An important caveat of animal models in SFSS is that none have taken into account disease status in the recipient, a crucial consideration in human orthotopic liver transplants.

The role of arterial hypoperfusion in SFSS is less well studied as it is secondary to portal hyperperfusion. Low hepatic artery flow seen in post-transplant grafts was formerly thought to be related to diversion of blood through the splenic artery and was called "splenic artery steal syndrome" but is now considered to be due to a normal homeostatic mechanism termed hepatic arterial buffer response (HABR)[11]. The role of HABR is to maintain constant total blood flow to the liver and it is mediated by adenosine washout. Portal blood flow removes adenosine which has a local vasodilator effect on the arterial system[12,13]. However, in states of extreme portal hyperperfusion as seen in small-for-size grafts, an exaggerated HABR may contribute to ischemic injury[10,14]. In one porcine small-for-size model, an infusion of adenosine in 20% standard liver size grafts was able to inhibit HABR and significantly reduce graft injury as determined by histology[15].

PREDICTING SFSS

Is it possible to identify cases at greater risk of developing SFSS? Commonly cited pre-operative risk factors include GWRW < 0.8[16] or graft weight ratio less than 30%-40%[17], with small grafts at significantly greater risk of prolonged bilirubinemia and coagulopathy. The first study is notable as 88% of patients were pediatric recipients undergoing transplant post-Kasai procedure, not representative of the usual adult liver transplant population. However, more recent studies have suggested small graft size alone is insufficient to account for SFSS. One retrospective study of 107 patients[18] undergoing live donor (n = 76) and split cadaveric transplants (n = 31) found no significant difference in either incidence of SFSS or graft survival at one year between the GWRW < 0.8% group (n = 22) and > 0.8% (n = 85) group, although the author reported a significantly greater number of SFSS cases in the 0.8%-1.0% region. In another study on a series of 75 patients[19], no difference was observed in development of SFSS between those receiving grafts less than 40% standard liver volume (n = 26) compared to those that received more than 40% (n = 73). This discrepancy can be accounted for in several ways. Firstly, there is increasing recognition that factors such as graft steatosis, pre-existing portal hypertension, recipient Child-Pugh grade and venous congestion also contribute to SFSS. Secondly, retrospective studies may lack power to detect a significant difference as a much smaller proportion of patients receive small-for-size grafts. Thirdly, in the later studies, patients thought at greater risk of developing SFSS often receive prophylactic measures such as splenic artery ligation[18].

When small-for-size grafts are stratified by disease severity in the recipient, it has been shown that SFSS is more likely to occur in patients with Child-Pugh score B and C. One-year graft survival is also significantly lower if Child B and C patients receive grafts GWRW < 0.8% and this is in addition to the poor prognosis conferred by pre-operative disease severity[20]. However, Child-Pugh A recipients can safely receive grafts as small as GWRW < 0.6%. It has been suggested that pre-existing portal hypertension may exacerbate the hyperperfusion seen in SFSS.

STRATEGIES TO PREVENT SFSS: MODULATING INFLOW

Since portal hyperperfusion is thought to be central to the pathogenesis of SFSS, the most popular strategies for prevention have focused on modulating inflow to the liver via inputs to the portal system. These include splenic artery modulation (ligation/embolisation), portacaval shunts and less commonly, splenectomy. To date, there are no studies directly comparing outcome from these techniques.

Splenic artery modulation techniques

Splenic artery modulation (SAM) was originally performed for portal hypertension secondary to cirrhosis. It was shown to be an effective treatment for post transplant patients exhibiting signs of SFSS, probably because of the reduction in portal pressure gradient[21]. In patients with portal hypertension, occluding the splenic artery reduces portal flow by 52% on average[22]. More recently, there is increasing tendency to perform SAM as a prophylactic procedure either based on algorithms predicting high risk of SFSS pre-operatively or based on intraoperative detection of high portal flow.

Gruttadauria *et al*[23] performed splenic artery embolisation (SAE) in six patients who developed SFSS after transplantation of GWRW < 0.8% grafts. Rapid resolution of symptoms occurred post SAE. However, one patient suffered massive colliquation of the spleen necessitating re-laparotomy and another suffered septic shock with consequent re-transplantation.

Two case-control series have tested the effectiveness of prophylactic splenic artery modulation[24,25]. Both studies found a significant reduction in portal flow following SAM and Umeda *et al*[25] were able to show a significant reduction in incidence of SFSS. Remarkably, neither group reported any cases of splenic infarction and this fortunate low complication rate was not replicated in other smaller case series[26]. This discrepancy in complication rates suggest splenic infarction may be reduced in experienced hands but remains a formidable problem.

Portacaval shunts

Portacaval shunting has gained favor in recent years due to its potential reversibility and to avoid possible splenic infarction[27,28]. Three case series where hemiportacaval shunts were constructed by anastomosing the right portal vein to the inferior vena cava have reported reasonable success in improving outcome of small for size grafts[29-31]. Portacaval shunts were able to reduce portal blood flow and pressure and lessen the likelihood of deranged liver function tests (LFTs) and international normalised ratio post operatively. One study[30] reported increase in graft survival from 20% in the control group to 75% in the shunt group.

In small-for-size rat models, however, concerns have been raised over the safety of a long term shunt[32] where a group of rat liver transplants with large portacaval shunts showed significantly worse graft survival rates at one year compared to the small shunt or no shunt groups. A case report from Japan where a portacaval shunt was constructed for small-for-size living donor liver transplantation (LDLT) noted progressive graft atrophy and a decision was made to close the shunt at 11 months. Fortunately this resulted in regeneration of the graft[33].

The natural history of a portacaval shunt is to occlude with time. In one study[31], 55% of shunts remained patent at six months and only 20% were patent at one year. In the shunts that remain patent, it is possible that persistent diversion of blood flow to the liver will compromise long term viability of the graft through mechanisms such as chronic ischemia. Hence shunts are likely to improve graft survival in the weeks immediately post operatively by reducing incidence of SFSS but may become a liability in the long term. Is there an optimum time, then, for electively closing the shunt?

MIDDLE HEPATIC VEIN CONTROVERSY: DONOR SAFETY *VS* GRAFT CONGESTION

The middle hepatic vein (MHV) is considered "dominant" in drainage of the hemiliver in 27% of cases[34]. A right hepatectomy without the MHV or reconstruction can induce congestion of the paramedian segments V and Ⅷ, reducing functional capacity of the graft. Harvesting the MHV in extended hepatectomy increases the risk of complications in the donor. The questions are therefore threefold: should we harvest or reconstruct the MHV? If so, which recipients would benefit most? What is the risk to the donor?

Lee *et al*[35] reported grafts without the MHV exhibited congestion of the right median sector leading to ascites and severe LFT derangement. Kamei *et al*[36] introduced the concept of non-congestive GRWR (ncGRWR) as a better measure of graft function than size ratio alone and showed patients with ncGRWR < 0.65 developed prolonged cholestasis, one of the features of SFSS.

Other studies found no significant difference in graft survival with or without harvest of the MHV as long as a vein interpositional graft was used for anastomosis[37,38]. It is important to note that most studies on MHV included grafts of all sizes. If we stratify grafts by size, the importance of venous congestion emerges[39,40]. In a series of 120 patients where 67% had reconstruction of MHV, there was no significant benefit in venous reconstruction for a large graft. For small-for-size grafts (GWRW < 1), however, patients who did not have venous reconstruction had deranged LFTs for significantly longer periods of time and also had slower regeneration of the graft (95% *vs* 80% at one month). In the medium term, grafts with reconstruction of the MHV had higher rates of survival at six months[41].

In the early days of living related and split cadaveric grafts, the decision to harvest the MHV was set by institutional policy. More recently, several centers have tried to rationalise harvesting the MHV by designing algorithms to predict recipients most likely to suffer small-for-size

syndrome. One of the earliest algorithms incorporated donor-recipient weight ratio, right lobe-to-recipient standard liver volume estimate and donor hepatic vein anatomy, including diameter and number of tributaries[42]. This split the patients into two cohorts with comparable baseline demographics and they were able to obtain similarly low complication rates regardless of whether the MHV formed part of the graft. Later algorithms have incorporated hepatic vein dominance measured by 3D CT and congestion volumes[43]. This is potentially better representative of the relative importance of the MHV.

Since safety of the donor is paramount in transplant surgery, it is important to quantify the risk. In one series (n = 105) where the MHV was not harvested, 13.3% of donors experienced major complications with eight patients requiring invasive paracentesis and three requiring further surgery. Does harvesting the MHV confer additional risk to the donor? Contrary to common belief, there is in fact remarkably little solid evidence to support this. Dayangac *et al*[44] found right hepatectomy with MHV harvest does not affect donor liver function or increase donor morbidity compared to control unless the liver remnant is < 30%. Congestion in segment Ⅳ of the donor is a common observation after MHV harvest but its long term significance is debatable. In donors who experienced mild, moderate and severe congestion, LFTs were significantly increased in the severe group at seven days post operation but by the end of the first month after transplantation all three groups had normal LFTs[45]. Congestion has been reported to reduce rate of regeneration in segment Ⅳ in the donor; however, compensatory growth in segments Ⅱ and Ⅲ was able to make up the shortfall[46].

REGENERATION PARADOX

The molecular basis underlying liver regeneration is highly complex and beyond the scope of this review. Here, we wish to briefly address the interesting observation that size of partial liver grafts is negatively correlated to rate of regeneration and the clinical implications of this finding.

It has been noted that liver size is related to the functional demands placed upon it by the body. Hence small-for-size grafts undergo compensatory growth whereas large-for-size grafts shed cells by apoptosis[47]. Smaller grafts have been shown to have a higher rate of regeneration despite showing signs of endothelial injury and sinusoidal congestion[48,49]. However, fast regeneration is not necessarily predictive of good outcome, as a porcine small-for-size model showed that proliferative activity in non-surviving grafts peaked earlier and higher whereas surviving grafts demonstrated a slower but maintained rise[8].

A body of evidence suggests liver graft regeneration is related to velocity and volume of portal flow. Park *et al*[50] have demonstrated a correlation between portal venous flow or velocity to graft weight ratio with short term regeneration in LDLTs. Regenerative rates have been shown to be proportional to spleen volume and portal inflow[51]. Cirrhotics generally experience faster regeneration compared to those undergoing transplants for other reasons, a phenomenon which is correlated to a persistent hyperdynamic portal venous circulation[52]. However, confounding factors cannot be ruled out when comparing cirrhotics to other transplant recipients. Portal hyperflow induced shear stress and nitric oxide release have been singled out as possible mediators in stimulating liver regeneration in the setting of partial hepatectomy[53,54]. The above findings have profound implications for splenic artery ligation and portacaval shunting techniques as these may compromise compensatory regrowth.

What is the optimal portal flow that will stimulate regeneration without damaging the graft? We need studies that quantitatively correlate portal flow to both rates of regeneration and severity of graft injury. One recent study tentatively suggests a threshold of portal venous flow to graft weight of 300 mL/minutes per 100 g on post operative days one to three, based on 18 LDLTs. Above this level, LFTs were significantly more deranged[55]. Larger, better controlled studies are needed to clarify this threshold which will have key therapeutic implications.

Portal hyperperfusion is thought to cause liver injury and defective regeneration *via* interleukin-6 and tumor necrosis factor (TNF)-α signalling. Tian *et al*[56] report a fascinating mouse model where TNF pathways were interrupted by receptor knockout, treatment and gadolinium chloride and pentoxifylline (PTX). These mice underwent 30% liver transplantation. In the groups with TNF pathway intervention better portal flow and sinusoid perfusion was seen with reduced leukocyte adherence. Graft survival was dramatically increased: 14% in controls, 57% in TNF receptor knockout, 43% in gadolinium chloride and 86% in PTX. This elegant demonstration shows it is possible to prevent the effects of hyperperfusion injury without physically reducing flow.

CONCLUSION

Small-for-size syndrome has become an increasingly well recognised condition with the rise in popularity of LDLT and split cadaveric grafts. Better understanding of its pathogenesis, risk factors and strategies for prevention will improve both donor and recipient outcomes and expand the potential organ pool.

Although many significant advances have been made in understanding and managing small-for-size syndrome, much work remains to be done. Of prime importance is an internationally agreed set of diagnostic criteria for SFSS which would help us to clarify the scale of the problem and enable future studies to be standardised.

Portal hyperperfusion appears to be the most important underlying mechanism for SFSS; however, we must remember that regeneration relies on an adequate blood supply and interventions to reduce SFSS should strike a delicate balance between avoidance of hyperflow injury and stimulation of regeneration. Independent contribution of poor hepatic arterial flow to graft dysfunction remains to be clarified. A gold standard measurement of portal hyperperfusion, whether portal venous pressure or flow, should be agreed. Crucially, we need to establish the

threshold level of hyperperfusion that does more harm than good.

Splenic artery modulation and portacaval shunting have both shown promise in prophylaxis and treatment of SFSS in multiple case series. Evidence from randomised control trials have so far been lacking but will perhaps become feasible with more LDLT and split cadaveric grafts being performed in the future.

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BRIEF ARTICLE

Pyogenic liver abscess: Changing patterns in approach

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Abstract

AIM: To define optimum management of the pyogenic liver abscess and assess new trends in treatment.

METHODS: One hundred and sixty nine patients with pyogenic liver abscess managed at Sher-i-Kashmir Institute of Medical Sciences, Srinagar, Kashmir (India) from July 2001 to August 2006 were studied to evaluate and define the optimum treatment.

RESULTS: Mortality in the surgically treated group of patients was 9.4% (12/119), while those treated non-surgically had a fatality rate of 16.66% (7/42). Multiple liver abscesses treated surgically had a surprisingly low mortality of 30%. The biliary tract (64.97%) was the most common cause of liver abscess. Multiple abscesses, mixed organisms and abscess complications are all associated with a significantly increased mortality. However, the lethality of the primary disease process was the most important factor in determining survival.

CONCLUSION: Transperitoneal surgical drainage and antibiotics are the mainstay of treatment. Percutaneous drainage is recommended for high risk patients only.

Key words: Liver abscess; Mortality; Antibiotics; Surgical drainage; Percutaneous drainage

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INTRODUCTION

Abscess of the liver has been recognised since the time of Hippocrates. Even today, it remains a surgical problem with considerable morbidity and mortality, as reported earlier[1]. The introduction of antibiotics and advances in bacteriology and diagnostic techniques have generally improved the outcome. A basic requirement for effective therapy is early diagnosis[2]. This has been made easier by the introduction of high resolution imaging techniques including ultrasound and computed tomography (CT). Current strategies to improve survival include earlier diagnosis, the use of percutaneous drainage under radiographic control, use of antibiotics and open surgical drainage. This study was undertaken with particular care devoted to ascertaining clinical features, the time interval between diagnosis and therapy, imaging studies, microbiology, initial treatment, necessity for retreatment and outcome, thereby defining optimum management of the pyogenic liver abscess and assessing new trends in treatment.

MATERIALS AND METHODS

All 169 patients in our study were subjected to detailed history taking, clinical examination, routine investigations and various specialised investigations. These comprised ultrasonography in all the 169 patients with 96% sensitivity and CT in 12 patients with 100% sensitivity. Final diagnosis of pyogenic liver abscess was confirmed later microbiologically and/or pathologically.

Pathogenesis, signs and symptoms, laboratory data, diagnostic tests, treatment, pathology, bacteriology, complications, and outcome were analysed. The pathogenesis was considered to be extrahepatic biliary disease if obstruction of the common bile duct was present or if cholangitis was documented concurrently with the liver abscess. The portal vein was implicated as the route of bacterial spread in all intra-abdominal infections within the portal system but remote from the liver abscess. The source of the liver abscess was considered to be generalized septicemia with bacterial entry via the hepatic artery, if the primary infection arose outside the portal system. No source of infection could be positively identified in the cryptogenic abscess.

After patients were thoroughly investigated, they underwent various modalities of treatment: (1) Non-surgical treatment: (a) Conservative management with antibiotics alone; and (b) Percutaneous drainage under USG guidance; and (2) Open surgical drainage.

Initially all uncomplicated patients were put on intravenous antibiotics. In those where the response was seen within 48-72 h, antibiotics were continued for 2 wk followed by oral antibiotics for 4 wk. Response was monitored by clinical examination and ultrasonography. Patients with the following criteria were taken for percutaneous drainage[3]: (1) Patients who continued to be febrile even after 48-72 h of adequate medical treatment; (2) Liver abscess more than 6 cm in size; and (3) Clinical or ultrasonographic features suggest impending perforation.

Open drainage was carried out in patients falling the Kapoor criteria[4] which are as follows: (1) Thick ous which could not be aspirated; (2) Patients with multiple liver abscess; (3) Patients with ongoing sepsis even after antibiotic therapy and percutaneous drainage; (4) Multiloculated abscess; (5) Abscess in the left lobe; and (6) Ruptured abscesses.

The length of illness was defined as time from the first symptom attributable to the liver abscess to the time of definitive treatment. The delay in diagnosis was from the first visit to a physician to the time of definitive treatment. Bacterial data was compiled from the initial culture results only. The abscess was considered microscopic if it was less than 2 cm in greatest dimension. Mortality was defined as death within 30 d of treatment or before discharge from the hospital.

RESULTS

Incidence

The incidence of pyogenic liver abscess found in our hospital over a five year period study was 0.03%.

Table 1 Origin of pyogenic liver abscess

No.	Origin	*n* (%)
1	Biliary calculi	45 (26.62)
2	Biliary ascariasis	30 (17.75)
3	Cholecystitis/cholangitis	33 (19.52)
4	General sepsis/hematogenous seeding	19 (11.24)
5	Pancreatitis	11 (7.00)
6	Portal vein sepsis	6 (3.82)
7	Recent gastric or duodenal surgery	3 (1.91)
8	Cryptogenic	22 (13.01)
	Total	169 (100)

Table 2 Symptoms and signs

No.	Symptoms	%	Signs	%
1	Malaise	98	Abdominal tenderness	70
2	Anorexia	92	Hepatomegaly	65
3	Fever	91	Right upper quadrant pain	62
4	Weight loss	75	Pulmonary changes	38
5	Chills	35	Jaundice	34
6	Vomiting	18	Epigastric pain	14
7	Chest pain	15	Peripheral Edema	9
8	Nigh sweats	12	Splenomegaly	8
9	Cough	12	Diffuse pain	7
10	Diarrhoea	10	Right flank pain	4

Age and sex

The average age was 42 years and ranged from 22 to 65 years. Majority of patients were in their fourth decade. Out of 169 patients, 102 were females and 67 males ($P > 0.01$).

Pathogenesis

The pathogenesis of hepatic abscesses with the frequency is shown in Table 1. Biliary tract disease was the most common source, although no source could be determined in 22 patients (13.01%) despite a thorough investigation. In our series biliary ascariasis was found in 17.75%. Cholecystitis and cholangitis accounted for 19.52% of patients. Generalized sepsis with a medical diagnosis of pyrexia of unknown origin accounted for 10.19% of our patients.

Clinical features

The liver abscess was an indolent process in which 70% had the illness longer than 2 wk and 43% had the diagnosis delayed by more than 2 wk.

The symptoms and signs in this patient population are shown in Table 2. Abdominal tenderness and hepatomegaly were the most helpful signs in suggesting a liver abscess. Pulmonary changes were present in 38% of the patients but the changes lateralized to the side of the pathology in only 14%. Twenty eight of the 34 clinically jaundiced patients had extra hepatic biliary diseases.

Associated diseases

Diabetes mellitus was present in four patients, severe chronic obstructive pulmonary disease in five patients and severe anaemia in thirty five patients. All individuals asso-

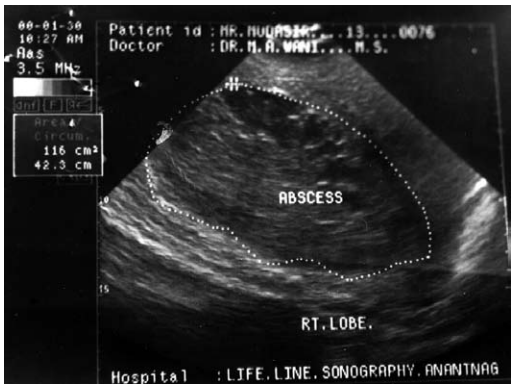

Figure 1 Ultrasonographic picture showing abscess in the right lobe of the liver.

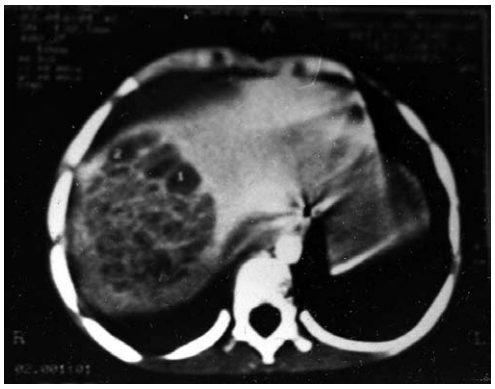

Figure 2 Computed tomography scan picture showing abscess in the right lobe of the liver.

ciated with some type of co-morbidity were considered as high risk patients.

Laboratory data/diagnosis

Hemoglobin level of the less than 10 gm% was found in 59% of patients, total leucocyte count more than 10000/cumm in 68% of patients, serum transaminases and alkaline phosphatase levels were elevated in 84% of patients. Prothrombin time index was less than 60% in 60% of patients. Blood culture grew *Escherichia coli* (*E. coli*) in 35% and *Klebsiella* in 23% in patients. Pus culture grew *E. coli* in 43% and *Klebsiella* in 25% of patients.

Ultrasonography (Figure 1) had a sensitivity of 96% in diagnosing liver abscess while as CT (Figure 2) scans showed a sensitivity of 100%. A single abscess was found in 70% and multiple abscesses in 30% of patients. Right lobe involvement was found in 68% while left lobe involvement was found in 22% and bilobar involvement in 10% of patients.

Treatment modalities and outcome

Antibiotics were used in all patients regardless of the mode of management. Open surgical drainage comprising 75.14% of patients had hepatotomy and drainage of the abscess with an accompanying liver biopsy. Drains were placed in all these patients but the type of drain did not appear to affect the outcome. Percutaneous drainage

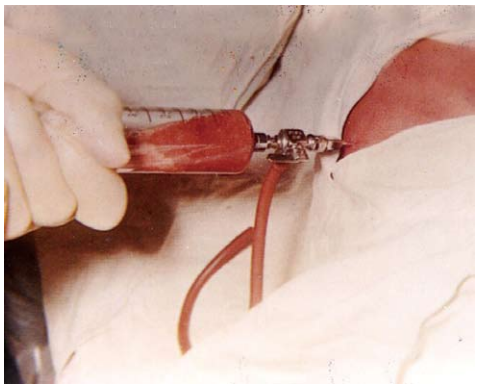

Figure 3 Percutaneous drainage of liver abscess being carried out.

Table 3 Various modalities of management used in the patients

No.	Treatment modality	*n*	Success rate (%)
1	Open surgical drainage	127	122 (96)
2	Percutaneous drainage	26	20 (77)
3	iv antibiotics only	16	6 (37.5)
	Total	169	

Nine patients with open surgical drainage had to undergo re-exploration as they had recurrence of abscess.

(Figure 3) of the hepatic abscess was performed in 15.38% (n = 26) of patients using ultrasonography as a guide for the procedure (Table 3).

Intravenous antibiotic therapy was used as the sole initial modality of treatment in 9.46% (n = 16) of patients in our series. Open surgical drainage was carried out in 62.5% (10 patients) among this group as the patients did not show any response to medical treatment. Among the percutaneous aspiration group 23% (6 patients) needed open surgical drainage after the initial procedure because of inadequate drainage by the percutaneous method. Among patients with open surgical drainage, drainage of abscess cavity alone was carried out in 62 (49%) patients, cholecystectomy, common bile duct exploration and drainage of abscess was carried out in 53 (41.73%) patients, along with T-tube drainage, while as cholecystectomy with drainage of liver abscess was done in 7 (5.51%) patients. Peritoneal lavage was carried in 5 (4%) patients, as they had presented with ruptured liver abscesses (Table 4).

Bacteriology

Positive culture results were obtained in 119 patients and 14 cultures had no growth identified probably because of antibiotic usage over prolonged period. A single organism was present in 44 (58%), while 61 (41.9%) of the cultures had two or more organisms. No culture was obtained in 38 patients. The mortality rate was low (36%) in those patients who were single organism positive and high in patients with mixed organisms in their abscess (64%). Gram negative aerobes were predominantly present in positive cultures (61%). Blood culture results were positive in 55% of the patients with cholangitis.

Table 4 Operative procedures performed on the patients

No.	Operative procedure	*n*
1	Drainage of abscess alone	62
2	Draining of abscess with cholecystectomy with common bile duct exploration	53
3	Drainage of abscess with cholecystectomy	7
4	Drainage of abscess with peritoneal lavage	5
	Total	127

Complications

Thirty four patients (20.11%) in our series developed complications followed either surgical or nonsurgical therapy (percutaneous aspiration drainage or intravenous antibiotics). Septicemia was the most common complication and carried a mortality rate of 85%. The frequency of major complications in shown in Table 5.

Death analysis

Death occurred in 19 patients with pyogenic liver abscesses. There were more deaths within the non surgically drainage group (7 out of 42 patients) than the surgically drained group (12 out of 127 patients) (Table 5). Henceforth, open surgical drainage remains the preferred treatment for pyogenic liver abscesses rather than less invasive options i.e percutaneous drainage and/or medical therapy. In 9 patients (7%) re-exploration for recurrence of abscess after initial surgical drainage was performed. The overall mortality in our series was 11.24%. The surgically treated group had a mortality of 9.4% (12 patients), while mortality among the non-surgically treated group was 16.66%. All seven surgically managed patients who died had some associated morbidity ($P < 0.05$), including diabetes in two, chronic obstructive pulmonary disease in two and anemia in one. In the surgical group, ten out of twelve deaths had an associated morbidity ($P < 0.05$), including diabetes in one, chronic obstructive pulmonary disease in three and anemia in six (Table 6). Klebsiella pneumonia was the organism most commonly grown from the cultures of patients who died during our study, both surgical and non-surgical (Table 7).

Table 5 Major complications and their frequency

No.	Complication	%
1	Septicemia	22
2	Intra Abdominal abscess	11
3	Recurrent liver abscess	4
4	Renal failure	4
5	Hepatic Failure	3
6	Massive upper gastrointestinal blood	3
7	Free peritonitis	2
8	Prolonged billiary drainage	2
9	Mortality	
	Non surgical group	7/42 (16.66)
	Surgical group	12/127 (9.44)

DISCUSSION

Pyogenic liver abscess is still a serious illness and a diagnostic challenge[5,6]. This is reflected in significant mortality rates and is a result of the lack of specificity of clinical signs[7] and laboratory results. New imaging techniques such as ultrasound and CT scan have made the differential diagnosis easier but cannot always rule out parasitic abscesses[8] or primary and metastatic hepatic tumor[9]. Diagnosis can be missed even intra-operatively[10]. The results of our series confirm the decreasing incidence of portal pyemia[11] and support the rising incidence of abscesses related to biliary disease generally reported elsewhere (31% to 45 %)[5,6,10,12-14]. Our 9.55 percent incidence of "Cryptogenic" abscess is lower than the 12 to 20 percent incidence reported commonly[9,14,15].

The majority of liver abscesses have an underlying source that must be controlled before successful treatment of the abscess is possible. Most patients with hepatic abscesses can be cured with aggressive surgical and antibiotic therapy if the origin of the abscess is removed. Open surgical drainage has been the traditional treatment, although percutaneous drainage is available because of newer radiologic techniques. Historically, liver abscesses developed in otherwise healthy patients with an intra-abdominal infection. Ochsner reported a peak incidence in the fourth decade, as has been found in our series. The incidence of pyogenic liver abscess found in our series over a five year period was 0.03% which is similar to that reported by others[1,14]. In this study, significantly more females were affected because of the increased incidence of biliary calcular disease in women. Most studies show a male majority[1,15], although recent reports suggest a trend to an equal sex incidence[14,16]. This study contradicts that view.

The source of the liver abscess greatly affects the subsequent mortality. Extra hepatic biliary disease was the largest etiologic group in this series, in agreement with the report by Miedema *et al*[9] in 1984. Mortality as high as 79% has been reported in this etiologic group[14] while the rate in our series was about 62%. Unfortunately, most of these deaths are not preventable with the present day therapeutic tools. Most had non reconstructable biliary tract disease, and the hepatic abscess reflected an inability to deal adequately with the primary disease. A more aggressive approach to the diagnosis and treatment of biliary disease in general will salvage a small proportion of these patients.

Biliary ascariasis leading to a liver abscess via the common bile duct or the portal vein is of special interest in this series. The association of biliary ascariasis with cholangitis has been well documented[17,18]. The fact that biliary ascariasis is one of the common etiologic factor in our series is probably because of high incidence of ascaris lumbricoides infestation in this region[18]. Worms have been recovered from abscess cavities in the majority of our patients among this group. With the large number of cryptogenic abscess in this and other reports, a better understanding of the underlying pathogenesis is needed. Incidences have been reported ranging from 4% to nearly 60%[1,19], although in recent series a fairly consistent 20%

Table 6 Impact of co-morbidity on mortality

Comorbidity	No. of deaths in surgical group (n = 12)	No. of deaths in non-surgical group (n = 7)	Total deaths (n = 19)	P-value
Diabetes (n = 4)	1	2	3	> 0.05
Chronic obstructive pulmonary disease (n = 5)	2	2	4	< 0.05
Anemia (n = 35)	4	3	7	< 0.05

P > 0.05 (insignificant), P < 0.05 (significant).

Table 7 Impact of organism cultured on the outcome of disease

Complications [organism(s) cultured]	Recurrent sepsis		Acute respiratory distress syndrome		Wound infection		Recurrence		Mortality	
	S	NS	S	NS	S	NS	S	NS	S	NS
Escherichia coli	1	1	0	0	1	0	1	1	2	2
Klebsiella pneumonia	2	2	1	1	0	0	1	1	6	4
Streptococcus pneumonia	1	0	1	1	0	0	0	0	1	0
Staphylococcus epidermidis	0	0	0	0	0	0	0	0	0	0
Staphylococcus aureus	0	0	1	0	1	0	0	0	0	0
Bacteriodes fragilis	1	0	0	0	0	0	1	0	1	1
Pseudomonas aeruginosa	1	1	0	0	0	0	0	0	2	0

S: Significant; NS: Non significant.

incidence has been reported[14-16]. The incidence in this series of 9.55% is lower than most recent reports but correlates well with the 11% incidence reported by Sherman and Robbins in an autopsy study at the Mallory Institute of Pathology[20].

Many investigators have tried to find a unifying pathogenesis for all cryptogenic hepatic abscesses but multiple causes appear to be involved. Our data is consistent with the observation of Beaver that most abscesses are secondary to an infection within the region of portal drainage[21]. This may be from a healed focus or from a persistent underlying disease that was not identified in the diagnostic evaluation. The culture results also add validity to this thesis, since majority of cultures grew gastrointestinal flora.

Newer radiological techniques such as ultrasound and CT scanning have greatly enhanced our ability to establish the diagnosis of hepatic abscess and have increased our understanding of the natural history of this process. Ultrasonography is the preferred initial tool for the diagnosis of liver abscess with a sensitivity of 85% to 95%. Ultrasound can identify lesions more than 2 cm in diameter. On the other hand, CT offers several advantages over ultrasonography. It has a sensitivity of 95% and can detect abscesses as small as 0.5 cm. CT can also delineate small abscess near the diaphragm and in fatty livers. CT also helps in detecting any associated intra - abdominal pathology including pancreatic masses, colonic cancers, diverticulitis, appendicitis and intraperitoneal abscesses. All our patients were subjected to ultrasound examination and a sensitivity of 96% in diagnosis was achieved. Only 12 patients in our series were subjected to CT scan examination with a sensitivity of 100%. Ultrasound is also cost effective as compared to CT scan. Ultrasound was found to be useful in the percutaneous drainage group and in the group treated with antibiotics alone. It has proved a very useful technique for documentation of the course of the hepatic abscess in our series. On ultrasound scans the pyogenic liver abscess appears as a hypoechoic lesion with irregular margin. Within the lesion these may be irregular areas of increased echogenicity. On the other hand liver abscess on CT appears as a low density lobulated lesion with poorly defined edges[22]. Hepatic scans utilizing radioisotopes are obsolete for definition of hepatic abscess while magnetic resonance imaging does not provide information of greater usefulness than ultrasound or CT scanning[23].

Surgical treatment continues to give the best chance of survival in patients with pyogenic liver abscess. The surgical mortality of 11.24% is a marked improvement over the previous mortality rate of 69% reported by Ochnsner, De Bakey and Murray from 1928-1937. Surgical intervention has the advantage of thorough exploration of the abdomen and extirpation of known or unsuspected primary foci of infection that might not have been detected in imaging[24,25].

We recommend transperitoneal surgical drainage to allow abdominal exploration and thorough exploration of the liver for multiple hepatic abscesses. From our series it is difficult to evaluated which type of drain is best. However, dependent drainage with multiple drains consisting of large tube drains and soft rubber drains is recommended. The tube drains in particular allow for diagnostic contrast studies and even irrigation treatment after surgery.

Medical treatment alone without any drainage procedure has shown poor results in our series. Only 16 patients (9.46%) were subjected to this modality of treatment in our series and 10 of these patients (62.5%) subsequently needed open surgical drainage because of poor response to antibiotic treatment alone. The poor success rate has

been documented by others as well[1,14,26]. Although some continue to encourage the use of antibiotics alone to treat the pyogenic liver abscess[27], this approach seems risky and we, therefore, recommend that all liver abscesses of pyogenic origin should be drained to provide optimum treatment.

Percutaneous treatment of abdominal[28] and pyogenic hepatic abscesses[22,29] has been praised for its simplicity and excellent results. Although of considerable benefit, percutaneous drainage is not necessarily the best treatment for all patients and is associated with a significantly higher failure rate than surgical drainage[22,29]. This is also evident from our series where 26 patients (15.38%) were subjected to this mode of treatment and 6 patients (23%) among them subsequently needed open surgical drainage because of inadequate response to percutaneous drainage. It is recommended that several factors be considered in choosing between surgical and percutaneous drainage. These include the anaesthetic risk posed to the patient, the presence or absence of a coexisting primary intra-abdominal pathology requiring surgery, the relatively limited size of the drains that can be introduced percutaneously, the complication and failure rates of the two procedures and also the local expertise. Percutaneous drainage of liver abscesses does hold promise for definitive therapy or to delay surgery in high risk patients who may not tolerate general anaesthesia. However, a prospective randomized trial comparing patients drained surgically or percutaneously is needed to evaluate differences in cost and morbidity. Bari *et al*[22] compared the results of percutaneous aspiration of liver abscess with open drainage in children. They concluded that open surgical drainage is the best modality of management for liver abscess.

We conclude with the message that although percutaneous drainage is safe and effective the open surgical procedure is the most reliable and effective means of management because we can deal not only with liver abscess, but also with associated intra abdominal pathology.

COMMENTS

Background

Liver abscess is a distinct clinicopathologic entity with systemic manifestations of toxemia and vague clinical signs in the abdomen. Modern non-invasive tests are highly sensitive in diagnosing liver lesions. Difficulty remains in identifying small hepatic abscesses and differentiating large abscesses from tumor.

Research frontiers

Pyogenic liver abscess is a potentially fatal disease. Over the decades, there has been significant improvement in its mortality. This has been attributed to the introduction of antibiotics, advances in imaging studies and critical care. There has also been a paradigm shift in the treatment modality of choice from the traditional open surgery to the minimally-invasive percutaneous drainage. However, whether this has lowered the mortality rate is debatable. The treatment of choice remains controversial. The aim of the study was to define optimum management of the pyogenic liver abscess and to assess new trends in treatment.

Innovations and breakthroughs

While percutaneous drainage is appropriate as first-line surgical treatment in most cases, open surgical drainage is prudent in cases of rupture, multi loculation, associated biliary or intra-abdominal pathology. Percutaneous drainage may help to optimize clinical condition prior to surgery. Laparoscopic drainage show promising results and is a feasible surgical option for the future.

Applications

The final verdict on the outcome of percutaneous versus open surgical drainage of pyogenic liver abscesses requires further studies in a controlled trial setting. Nevertheless, in current good clinical practices the choice of therapy needs to be individualized according to patient's clinical status and abscess factors. The available therapies are complementary in the management of liver abscesses. This study may represent a future strategy for therapeutic intervention in the treatment of patients with pyogenic liver abscess.

Peer review

The authors undertook an extensive study to assess the clinical presentation, diagnosis and management of patients with pyogenic liver abscess. The aim was to define optimum management of the pyogenic liver abscess and assessing new trends in treatment.

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CASE REPORT

Small bowel obstruction presenting with a rectal haematoma

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Abstract

We report on a case of an 85-year old man with an unusual presentation of small bowel obstruction. A palpable mass on digital rectal examination was subsequently visualised endoscopically with the appearance of a haematoma. The presence of a rectal mass as a presenting sign for small bowel obstruction is highly unusual and unreported in the literature.

Key words: Small bowel obstruction; Rectal mass; Haematoma

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INTRODUCTION

Small bowel obstruction is a common surgical emergency the vast majority of which are secondary to adhesions from previous abdominal surgery, as well as hernias in the developing world. Diagnosis is usually swiftly made based on the history, examination findings and abdominal radiographic appearance. However a number of unusual modes of presentation have been reported in the literature together with several atypical causes for this condition. We describe one such case where diagnosis was not obvious initially and how rectal examination provided the clues necessary to proceed with this patient's treatment.

CASE REPORT

An 85-year-old male attended the Emergency Department complaining of abdominal pain. The onset of the pain had occurred over minutes and began 24 h previously. The pain was non-specific in description and localised in the periumbilical region. The patient reported that he had not passed flatus over the last 24 h and that his last normal bowel motion was four days ago. He had not vomited and described no weight loss. He also denied passage of blood or mucous per rectum. On further questioning he described a change in bowel habit over the previous two months. He was experiencing constipation and was managing this problem with over-the-counter laxatives. His past medical history consisted of osteoarthritis in the hip joints and he had undergone bilateral total knee replacements. His only regular medication was aspirin.

On examination, he was apyrexial with a pulse of 90 bpm. Respiratory rate, oxygen saturations and blood pressure were normal. The abdomen was soft and non-tender though mildly distended. On digital rectal examination

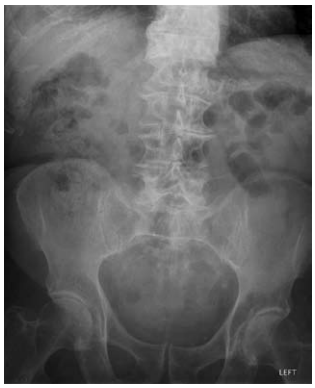

Figure 1 Abdominal radiograph appearances were non-specific.

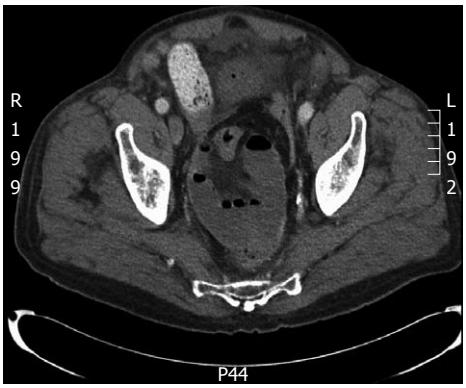

Figure 3 Computed tomography scan demonstrating the presence of dilated, fluid-filled loops of small bowel clumped together within the pelvis.

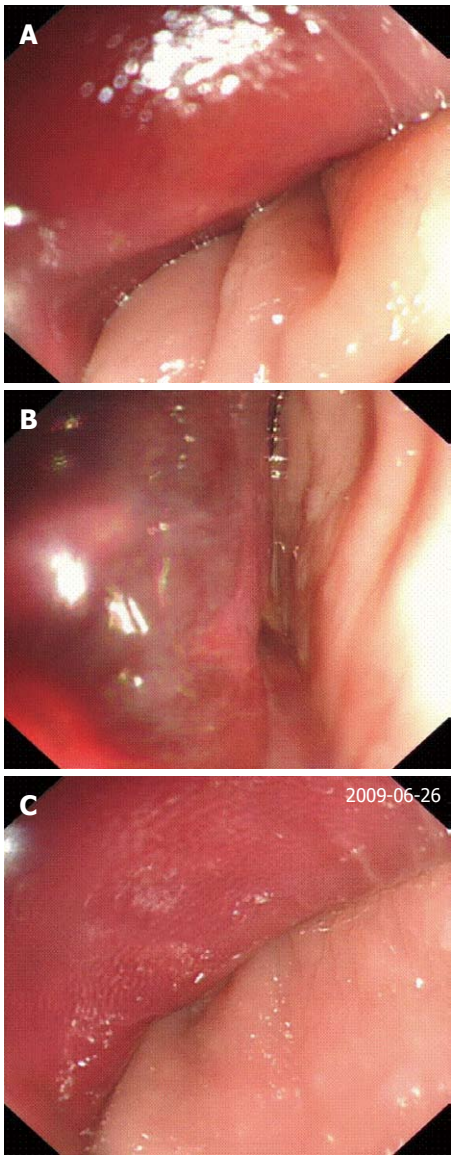

Figure 2 Images taken at flexible sigmoidoscopy demonstrating an extra-luminal mass putting pressure of the anterior rectal wall. A: Compression of the anterior rectal wall; B: Haematoma due to gangrenous small bowel loops; C: Pressure within the pelvic cavity acting on the rectum.

a soft bulge was felt on the anterior rectal wall. Blood tests on admission demonstrated dehydration (urea 11.1, creatinine 157) with raised inflammatory markers [C reactive protein (CRP) 278]. An abdominal radiograph (Figure 1) demonstrated some faecal loading but was otherwise featureless.

On his second day in the ward the patient became unwell, developing fast atrial fibrillation. He had begun vomiting and a nasogastric tube which was subsequently inserted was draining a high output. A flexible sigmoidoscopy performed because of the rectal mass demonstrated a normal distal rectum. However, 5 cm from the anal verge was a large extra-luminal mass which was purple-pink in colour (Figure 2). This had the appearance of a large haematoma in the rectovesical pouch. No mucosal lesion was identified. A computed tomography scan showed that the pelvis contained fluid-filled small bowel loops, of 3 cm in diameter, clumped together (Figure 3). Prominent small bowel loops were found in the central and upper abdomen with no cause of small bowel obstruction evident.

The patient was taken for a laparotomy which demonstrated distal small bowel obstruction secondary to bowel "incarcerated" within the rectovesical pouch. This small bowel was found to be frankly gangrenous as a result of strangulation, and was tethered to the pelvic brim. He was noted to have a narrow pelvic inlet and underwent resection for the gangrenous small bowel loops. After an uneventful postoperative recovery he was discharged home.

DISCUSSION

The flexible sigmoidoscopy findings together with the unresolving small bowel obstruction prompted a laparotomy where the diagnosis was confirmed. The palpable rectal mass due to a haematoma in the rectovesical pouch, which was visualised at flexible sigmoidoscopy (Figure 2), was due to the presence of gangrenous small bowel which had become strangulated within the confined area of this patient's notably narrow pelvic inlet. The rectum, being adjacent to this mass of small bowel, was inflamed and oedematous. This probably led to the formation of a haematoma within the rectal wall, which resulted in this most atypical presenting sign.

In males the rectovesical pouch is formed by the part of the peritoneal cavity between the rectum and bladder.

There are instances where disease can localise to this region. The most likely pathology is build-up of fluid and abscesses, for example, secondary to appendicitis[1]. Clinically this may be detected by palpating an anterior rectal wall mass on digital rectal examination.

The differential diagnosis of masses palpable per rectum can be divided into causes that are intrinsic (either intra-luminal or within the rectal wall) or extrinsic. Extrinsic causes put pressure of the rectum resulting in the palpable mass. Rigid/flexible sigmoidoscopy will enable the clinician to determine if the mass is extrinsic as with this patient, where the mucosa appeared uninvolved.

It is believed that the narrow inlet of the pelvic cavity in this patient was responsible for the small bowel becoming trapped. The greater transverse mid-inlet and pelvic outlet diameters in females are anecdotally considered by colorectal surgeons as providing better access in operations deep within the pelvic cavity, making the surgery easier than in males[2,3].

The incarceration and subsequent strangulation of small bowel within the pelvic cavity would be comparable to the pathology involved in internal herniae. In this case the hernia would be represented by the rectovesical pouch with the narrow pelvic inlet behaving as a tight neck. Our case report details the only instance of herniation within the rectovesical pouch of the pelvis.

Strangulation of small bowel within the pelvic cavity is a possibility in males where the inlet may be particularly constricted. This can rapidly lead to ischaemic bowel and therefore significant mortality and morbidity. Awareness of this pathology in patients presenting with atypical small bowel obstruction (SBO) is important as well as recognition that digital rectal examination findings may be indicative of small bowel strangulation.

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CASE REPORT

Surgical treatment for abdominal actinomycosis: A report of two cases

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Abstract

Since actinomycosis sometimes causes an abdominal tumor which mimics malignancy, treatment strategy varies from case to case. We herein report two cases which were treated with a combination of antibiotics and surgical intervention. Both patients presented with an intra-abdominal tumor lesion mimicking malignant disease after an appendectomy for acute appendicitis. Case 1 received surgical extirpation of the abdominal tumor in the liver and kidney twice since the clinical diagnosis of actinomycosis was not made. In contrast, case 2 was successfully treated by a combination of antibiotics and laparoscopic surgery following the experience of case 1. When a high probability diagnosis can be made, a laparoscopic approach is a useful and effective option to treat this condition.

Key words: Abdominal actinomycosis; Surgical therapy; Laparoscopic surgery; Single port surgery

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INTRODUCTION

Actinomycosis is a chronic suppurative granulomatous inflammation caused by the Actinomyces species, a microaerophilic, anaerobic Gram-positive rod[1]. The disease process includes an autologous infection mainly induced by surgery. The abdomen is the most frequent site for actinomycosis and when an abdominal tumor presents as the clinical symptom, the local lesion needs to be differentiated from abdominal tumors of other etiologies, malignancy in particular. Preoperative diagnosis is usually difficult with the majority of cases being diagnosed after the histological and bacteriological examination of the resected specimen[2-5].

We herein report on two cases which were treated with a combination of antibiotics and surgical intervention. When actinomycosis is already presumed with a high probability as the clinical diagnosis beforehand, a laparoscopic approach is a useful option to treat this entity, providing beneficial effect for patients quality of life.

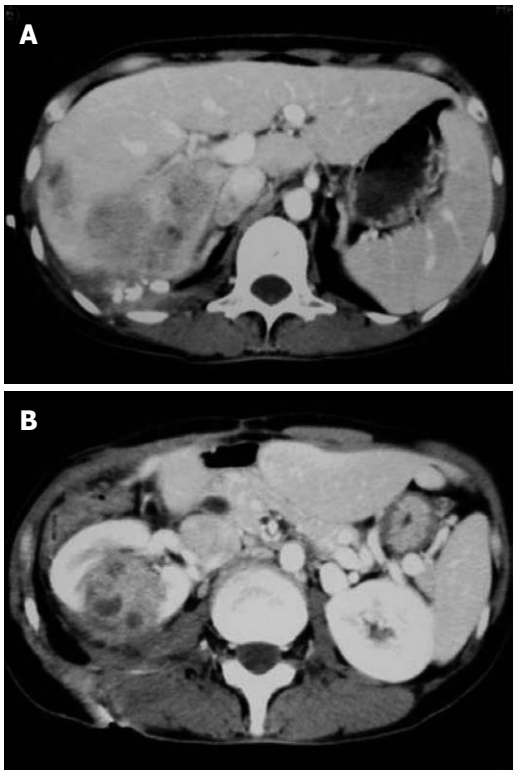

Figure 1 Image findings of case 1. A: Abscess cavity mimicking malignant liver tumor occupied in the posterior segment of the liver; B: Abscess formation found at the right kidney 3 mo after hepatectomy.

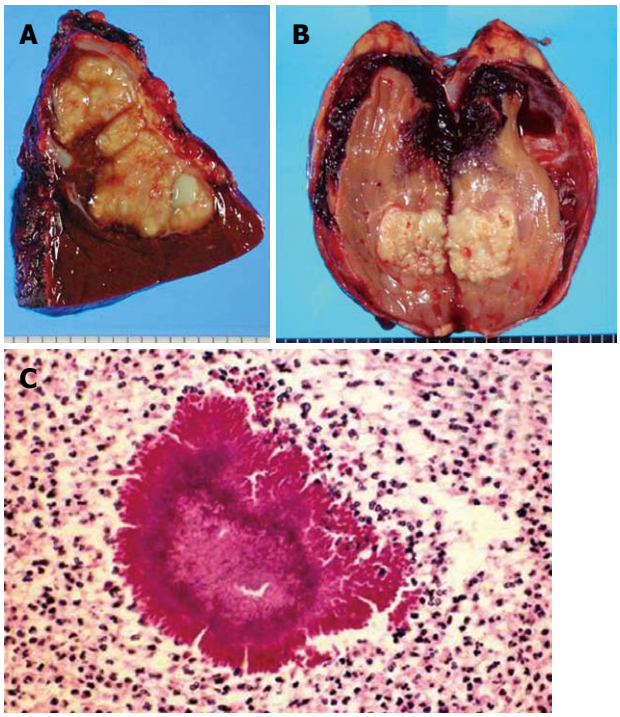

Figure 2 Resected liver (A), resected kidney (B) and pathological examination of the resected kidney (C) of case 1. A: The lesion in the resected liver was a macroscopically whitish node with capsule; B: The resected kidney showed the same nature as the liver tumor; C: The pathological examination of the resected kidney revealed a typical abscess due to *Actinomyces israelii*. Note the abscess contained filamentous bacterial colonies, i.e. sulfur granules.

CASE REPORT

Case 1

A 49-year-old Japanese woman presented with fever and right lower abdominal pain. She had received a laparoscopic appendectomy for acute gangrenous appendicitis 1 mo before at a nearby hospital. She had no relevant past or family history and did not have an intra-uterine contraceptive device. Mild grade inflammatory findings were noticed on her blood counts and serum biochemistries. On imaging analysis, a liver tumor was found and diagnosed as an abdominal abscess, subsequently treated by percutaneous drainage resulting in no substantial improvement clinically or radiologically, thus prolonging the conservation period remarkably. Bacterial culture of obtained pus showed *Enterococcus faecalis*. No malignant cells were observed. Although the abscess cavity decreased in size, the whole lesion expanded in segment 5 and 6 of the liver (Figure 1A) and the intrahepatic bile duct was visualized in the contrast study through the drain. Partial hepatectomy and curettage of the abscess wall was finally performed 2 mo after the initial drainage. The lesion in the resected liver was macroscopically a whitish node with capsule and histologically a chronic abscess without malignancy (Figure 2A). However, 3 mo after hepatectomy, she presented with high grade fever again and abscess formation was revealed at the right kidney (Figure 1B) for which a nephrectomy was performed (Figure 2B). The pathological examination of the resected kidney revealed an abscess due to *Actinomyces israelii* with characteristic "sulfur granules" and subsequently the previous specimen was retrospectively examined which revealed similar pathological findings; at this point actinomycosis was diagnosed (Figure 2C). She received intravenous administration of antibiotics for 3 wk followed by oral antibiotics for 3 mo, including ampicillin, sulbactam and minocycline. The patient is currently alive and well with no sign of recurrence 5 years and 8 mo after the last surgery.

Case 2

A 41-year-old Japanese woman was referred to our institute for an abdominal mass with mild abdominal pain in the right hypochondrial through flank region and low grade fever persisting for 4 mo. She had received a laparoscopic appendectomy for acute appendicitis 9 mo before at a nearby hospital. She had no history of intrauterine contraceptive device use. An intra-abdominal mass lesion, found at the first hospital, had increased in size at the time of presentation at the second hospital and fluorodeoxyglucose-positron emission tomography examination (FDG-PET) was performed for suspected malignancy which showed a high standardized uptake value (SUVmax: 11.6) for FDG at the tumor. Laboratory data showed only a mild increase in C-reactive protein and was otherwise normal, including tumor markers, blood count and biochemistry. Abdominal computed tomography (Figure 3) demonstrated a tumor 70 mm × 45 mm between the retroperitoneum and segment 6 of the liver, showing an irregularly circumferentiated, contrast-

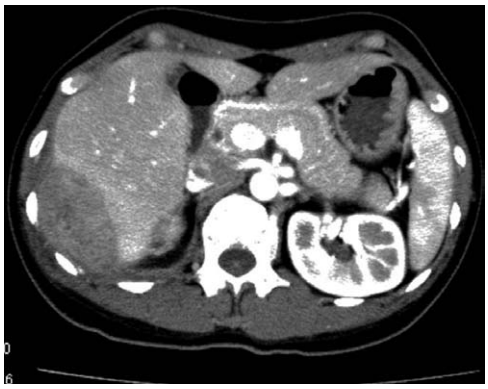

Figure 3 Preoperative computed tomography image of case 2. Tumor 70 mm × 45 mm in the right flank is observed invading to segment 6 of the liver, showing an irregularly circumferentiated, contrast-enhanced cystic structure with heterogenous content.

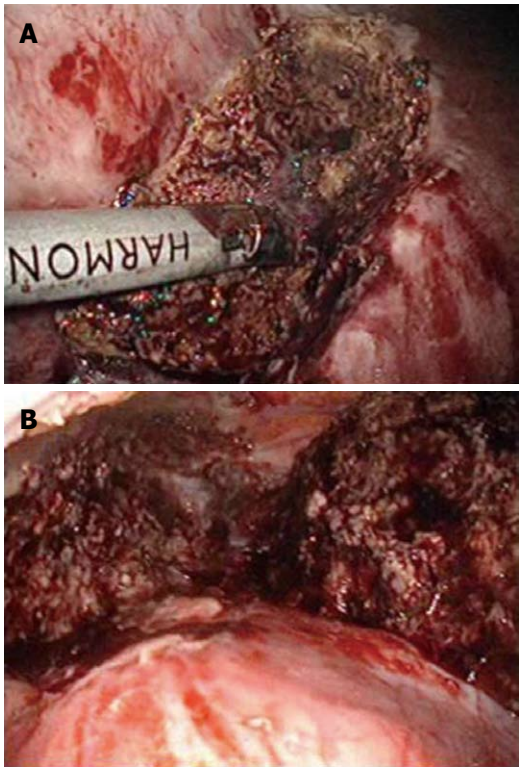

Figure 4 Intraoperative images of case 2. A: Liver parenchyma was transected by ultrasonic device. Bleeding was well controlled; B: Intraoperative view of the resected lesion. Operation was completed by single incision laparoscopic surgery without additional port.

enhanced cystic structure with heterogenous content inside. From these characteristic clinical course and imaging studies, she was diagnosed as having actinomycosis and was then treated with ampicillin, sulbactam and minocycline. The tumor decreased in size but abnormal C-reactive protein level and mild grade fever persisted; thus she had a laparoscopic resection [using single incision laparoscopic surgery (SILS) technique] of the tumor (Figure 4). A drain was not placed. Cholecystectomy was also performed using the same single-port simultaneously for known cholecystolithiasis. She was discharged home on postoperative day 10. The resected specimen revealed (Figure 5) intra-

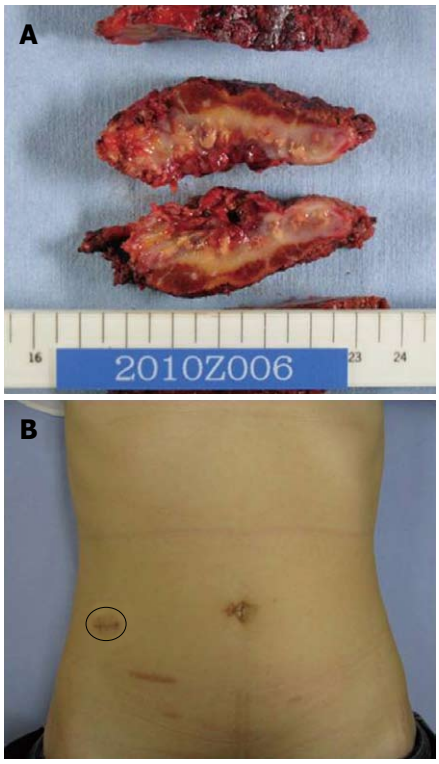

Figure 5 Resected specimen (A) and postoperative picture of abdomen (B) of case 2. A: Resected specimen revealed suppurative inflammatory tissue which consisted of abscess, granulomatous- and fibrous tissue in and around the liver; B: Circle indicates surgical wound of single port. Surgical scars of previous appendectomy are seen.

abdominal and intrahepatic abscess due to actinomycosis without malignancy. The patient received oral antibiotics postoperatively and is currently doing well with no sign of recurrence 3 mo after the last surgery.

DISCUSSION

Actinomycosis is a chronic or subacute suppurative granulomatous inflammation caused by the Actinomyces species, mainly *Actinomyces israelii*, a microaerophilic, anaerobic Gram-positive rod. Since *Actinomyces* is considered to be saprophytes in the oral cavity, gastrointestinal tract and female genital tract, some surgical triggers such as mechanical wounds, operation, placement of intra-uterine contraceptive device and teeth extraction may act to destroy the mucosal barrier function, resulting in facilitation of invasion of the pathogen into deeper tissue from its original habitat. Clinical features are classified into 3 subtypes: cervicofacial, thoracic and abdominal, and advanced type with systemic hematogenous dissemination of pathogen; the last of which sometimes causes a fatal outcome. In the abdominal type, the ileocecal region, including the appendix, is the most frequent site since the swallowed pathogen invading through defect of mucosa, i.e. ulcer lesion, causes the disease. Among the abdominal organs, liver, gall pathways, pancreas, gastro intestines and kidney are involved[2].

The differential diagnosis includes malignancies (such as sarcoma and cholangiocarcinoma), ameboma, inflamma-

tory bowel diseases (such as diverticular disease, intestinal tuberculosis and Crohn's disease) and pathological status within the abdominal muscles[6-8]. Definitive diagnosis is made by identification of this pathogen in the pus. Therefore, when faced with an inflammatory tumor after an episode of appendectomy or significant enterocolitis, actinomycosis should be listed on the differential diagnosis[5,9]. However, diagnostic accuracy by means of microbiological culture and biopsy is reported to be very low, thus making preoperative diagnosis difficult as in our case 1.

With respect to treatment, a natural cure is reported to be rare and early implementation of treatment including antibiotics and/or surgery is necessary[10]. Especially in the case of the systemic type, depending on the organ(s) involved, delay in treatment may be fatal. In this regard, case 1 appeared to be a systemic type with liver and subsequent kidney involvement showing a tendency to spread to the adjacent organ or tissue in which aggressive surgical treatment would be especially required.

While disease of a relatively earlier stage may respond to antibiotics mono-therapy, the majority of reported cases needed surgical intervention in addition to antibiotic administration[6]. Moreover, malignancy can not necessarily be ruled out completely. Although in case 2 in our series actinomycosis was highly suspected from our experience with our first case, surgical extirpation was eventually mandatory due to refractory nature of this case. In fact, the majority of patients shows an increased rate of recurrence after antibiotic therapy without simultaneous surgical resection of the infected area; thus combined therapy of antibiotics and surgery has been advocated as the most efficient treatment[2,6]. In such a situation, a laparoscopic approach would be the best option because of its minimal invasiveness. In fact, this is the first case, to the best our knowledge, to be treated laparoscopically. This procedure is also effective to dispense with cumbersome percutaneous abdominal drainage, enabling a shorter duration of whole treatment process. Furthermore, pretreatment with antibiotics would be beneficial to shrink the tumor to be excised and facilitate the laparoscopic operation as well as therapeutic diagnosis, as in our case 2. However, it should also be kept in mind that if malignancy is suspected during the laparoscopic procedure, immediate conversion to an open method is required.

SILS has been spreading recently as the least invasive procedure in the field of abdominal surgery. We applied this procedure on case 2 with satisfying results in terms of cosmetics and analgesics since even a simple drain insertion would have necessitated a single incision.

In conclusion, abdominal actinomycosis needs to be listed on a differential diagnosis when faced with an abdominal tumor lesion mimicking malignancy and a laparoscopic approach provides modality both of diagnostic and therapeutic effectiveness.

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Meetings

Events Calendar 2010

January 15-16, 2010
AGA Clinical Congress of Gastroenterology and Hepatology
The Venetian And Palazzo, 3355 Las Vegas Blvd South, Las Vegas, United States
http://www.gilearn.org/clinical-congress

January 27-31, 2010
Alpine Liver & Pancreatic Surgery Meeting
Carlo Magno Zeledria Hotel, Madonna di Campiglio, Italy
http://www.alpshpbmeeting.soton.ac.uk

February 25, 2010
Multidisciplinary management of acute pancreatitis symptoms
The Royal Society of Medicine, 1 Wimpole Street, London, United Kingdom
http://www.rsm.ac.uk/academ/pancreatitis10.php

March 4-7, 2010
2010 Annual Meeting of the Society of Surgical Oncology
Renaissance® St. Louis Grand Hotel, 800 Washington Avenue, St. Louis, Missouri, United States
http://www.surgonc.org/

March 25-28, 2010
20th Conference of the Asian Pacific Association for the Study of the Liver
Beijing, China
http://www.apasl2010beijing.org/en/index.aspx

April 14-18, 2010
The International Liver Congress™ 2010
Vienna, Austria

May 1-5, 2010
2010 American Transplant Congress
San Diego Convention Center, 111 West Harbor Drive, San Diego, United States
http://www.atcmeeting.org/2010

May 1-5, 2010
Digestive Disease Week 2010
Ernest N Morial Convention Center, 900 Convention Center Blvd, New Orleans, United States
http://www.ddw.org/

May 15-19, 2010
Annual Meeting of the American Society of Colon and Rectal Surgeons
Hilton Minneapolis Hotel & Convention Center, Minneapolis, Minnesota, United States
http://www.fascrs.org/

September 16-18, 2010
Prague Hepatology Meeting 2010
Prague, Czech Republic
http://www.congressprague.cz/en/kongresy/phm2010.html

September 23-25, 2010
2010 Gastrointestinal Oncology Conference
The Sheraton Philadelphia City Center, Philadelphia, United States
http://www.isgio.org/isgio2010/program.htm

October 20-23, 2010
Australian Gastroenterology Week
Melbourne, Australia
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November 13-14, 2010
Case-Based Approach to the Management of Inflammatory Bowel Disease
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Instructions to authors

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6 21st century heart solution may have a sting in the tail. *BMJ* 2002; **325**: 184 [PMID: 12142303 DOI:10.1136/bmj.325.7357.184]

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15 Morse SS. Factors in the emergence of infectious diseases. Emerg Infect Dis serial online, 1995-01-03, cited 1996-06-05; 1(1): 24 screens. Available from: URL: http://www.cdc.gov/ncidod/eid/index.htm

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16 **Pagedas AC**, inventor; Ancel Surgical R&D Inc., assignee. Flexible endoscopic grasping and cutting device and positioning tool assembly. United States patent US 20020103498. 2002 Aug 1

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