The Spectrum of Abdominal Tuberculosis in a Developed Country: A Single Institution's Experience Over 7 Years

Ker-Kan Tan · Kenneth Chen · Richard Sim

Abstract

Background The incidence of human immunodeficiency virus (HIV) infection is rising, and as a result, tuberculosis (TB) has become a resurgent problem in many developed countries.

Objectives The aim of this study was to review the spectrum of abdominal TB and its surgical management in our institution.

Methods A retrospective review of all abdominal TB cases notified to the health authorities by our institution from Jan 01 to Oct 07 was performed.

Results There were 57 patients (37 men) with abdominal TB, with a median age of 47 (range 14–74) years. Active pulmonary TB was present in 27 patients (47%). Positive HIV status was present in 30% and untested in 58%. The majority of patients underwent computed tomography scans ($n=50$, 88%). The main radiological findings included bowel thickening, lymphadenopathy, ascites, free gas suggestive of perforation, and abscesses. The diagnosis of TB was confirmed on microbiological and/or histological examination in 72%, while the remaining 28% were diagnosed based on the clinical presentation and radiological imaging. All patients were commenced on anti-tuberculous therapy. TB involved the small or large bowel in 33 patients, mesenteric lymphadenopathy in 24, peritoneum in 13, spleen in seven, pancreas in two, anus in two, and the liver in two. Disseminated (including pulmonary) TB occurred in 27 patients (47%), while isolated intra-abdominal TB occurred in the remaining 30 patients (53%). Twenty-five patients (44%) underwent surgery—16 laparotomies (six perforated viscus, five intestinal obstruction, three suspected malignancies, and two for suspected acute abdomen), five laparoscopic procedures (four diagnostic, one gastrojejunostomy bypass for gastric outlet obstruction), two appendicectomies, one drainage of abscess, and one anal fistulotomy.

Conclusions Although TB is eminently treatable medically, surgery is still often required for suspected or confirmed abdominal TB presenting with acute complications or as atypical diagnostic problems. The role of laparoscopy is likely to be more significant in future in the management of abdominal TB.

Keywords Tuberculosis · Abdominal · Surgery · HIV

Introduction

The World Health Organization (WHO) has estimated that there are approximately 8.8 million new cases of tuberculosis (TB) each year with an annual mortality of over 1.6 million.[1] The increased prevalence of human immunodeficiency virus (HIV) has accelerated the gravity of this epidemic.[2] Abdominal TB can infect the gastrointestinal tract, peritoneum, mesentery, abdominal lymph nodes, liver, spleen, and pancreas.[3–5] It also tends to mimic other inflammatory or neoplastic conditions.[6–8] Diagnosis is often delayed due to the lack of specific symptoms and laboratory findings. As a result, effective treatment is delayed with ensuing morbidity and mortality. In this study, we reviewed the spectrum of abdominal TB and its surgical management in our institution.

K.-K. Tan (✉) · K. Chen · R. Sim
Department of General Surgery, Tan Tock Seng Hospital,
11 Jalan Tan Tock Seng,
Singapore 308433, Singapore
e-mail: kerkan@gmail.com

Methods

Study Population

Tan Tock Seng Hospital is a 1,300-bed hospital in Singapore that provides medical care to over 1.5 million people. Our unit is the main surgical referral center for TB and/or HIV patients due to the proximity of both the TB Control Unit and Communicable Disease Centre. All newly diagnosed TB cases are notified and monitored by the Ministry of Health in Singapore. We performed a retrospective review of all patients that were diagnosed with abdominal TB in our institution between January 2001 and October 2007.

Definition

The diagnosis of abdominal TB was established by one of the following criteria: (1) definitive diagnosis—histologic and microbiologic evidence of *Mycobacterium tuberculosis*, the presence of granulomas with caseous necrosis, or successful culture of *M. tuberculosis* from the tissue specimen, or the presence of documented TB in another site with typical operative findings and granulomas; or (2) clinical diagnosis—clinical and radiological features of abdominal TB, responding to antituberculous medication in the absence of definitive diagnosis.

Clinical presentation is extremely varied, and therefore, clinical features alone cannot confirm the diagnosis of abdominal TB. Some of these clinical features include symptoms such as abdominal pain, diarrhea, vomiting, anorexia, weight loss, and pyrexia of unknown origin. The presence of abdominal mass, ascites, or intestinal obstruction is not uncommon.[9]

In our institution, most patients who were diagnosed to have abdominal TB had computed tomography (CT) scan performed. Typical radiologic features of abdominal TB include ascites, thickening of the peritoneum, mesentery, or bowel wall, and lymphadenopathy.[10–13] These lymph nodes are associated with low attenuation centers and enhanced rims suggestive of caseous necrosis.

If clinical suspicion of HIV infection is high, serology and Western Blot test would be recommended to confirm the diagnosis. However, the test could only be performed upon patient's consent after appropriate counseling. All patients with concomitant HIV infection were co-managed with infectious disease physicians, who ensured appropriate treatment for the abdominal TB as well as preventing opportunistic infection.

Results

There were 57 patients (65% males) who were diagnosed with abdominal TB with a median age of 47 (range 14–74)

years (Table 1). Two thirds of our patients were ethnic Chinese. The median duration of follow-up was 10 (range 0–21) months. The two main presenting symptoms were abdominal pain (61.4%) and fever (36.8%; Table 2). Twenty-four (42%) patients had their HIV status examined, with 17 (70.8%) of them tested positive. A significant 58% of the patients did not have their HIV status tested. The other important co-morbidities of abdominal TB included end-stage renal failure (10.5%) and long-term immunosuppressant (3.5%). Twenty-seven (47.4%) patients had active pulmonary TB at the time of diagnosis of abdominal TB. The majority of our patients (*n*=50, 87.7%) underwent CT scans of the abdomen and pelvis (Table 3). The common CT findings included bowel thickening (66%) (Fig. 1), ascites (40%), and lymphadenopathy (48%) (Fig. 2).

Definitive diagnosis was achieved in 41 (71.9%) patients, while in the remaining 16 (28.1%) who were diagnosed clinically, all responded to chemotherapy (Table 2). Antituberculous therapy was started for all patients, with the RHEZ (rifampicin, isoniazid, ethambutol, pyrazinamide) regime most frequently adopted.

Thirty-three (57.9%) patients had TB involving the small and large bowels. There were numerous patients with multiple diseased areas. The two most common regions of bowel involvement were ileum (63.6%) and caecum (48.5%) (Table 4). Other areas included the lymph nodes (42.1%), solid organs (19.3%), and the peritoneum (22.8%).

Twenty-five (43.9%) patients underwent surgery (Table 5). Ten (40%) of them were elective procedures, while 15 (60%) required emergency surgery. Of the ten elective procedures

Table 1 Patients Characteristics

Characteristics	Number of patients (%)
Age	
≤40	24 (42.1%)
>40	33 (57.9%)
Gender	
Male	37 (64.9%)
Female	20 (35.1%)
Racial distribution	
Chinese	35 (61.4%)
Malay	14 (24.6%)
Indian	5 (8.8%)
Filipino	2 (3.5%)
Thai	1 (1.8%)
HIV Status	
Positive	17 (29.8%)
Negative	7 (12.3%)
Unknown	33 (57.9%)
Active pulmonary tuberculosis	
Present	27 (47.4%)
Absent	30 (52.6%)

Table 2 Symptoms of Patients and Diagnosis of Abdominal TB

	Number of patients (%)
Symptoms	
Abdominal pain	35 (61.4%)
Fever	21 (36.8)
Vomiting or diarrhea	16 (28.1%)
Anorexia and weight loss	13 (22.8%)
Abdominal distension	13 (22.8%)
Diagnosis of abdominal tuberculosis	
Histological and Microbiological	5 (8.8%)
Histological only	19 (33.3%)
Microbiological	17 (29.8%)
Clinical diagnosis	16 (28.1%)

Figure 1 CT Scan showing significant thickening of the ascending colon (*arrow*).

(Table 5), four were laparotomies, five were laparoscopies, and one was a fistulotomy. Of the four laparotomies that were performed, three were for suspected malignancy and one for stricture causing intestinal obstruction. Most (*n*=4, 80%) of the laparoscopic procedures were for diagnostic purposes. The only therapeutic laparoscopic procedure was a gastrojejunostomy bypass that was carried out in a 53-year-old gentleman. He presented with symptoms of gastric outlet obstruction and was subsequently diagnosed with superior mesenteric artery syndrome due to severe weight loss from disseminated TB. Conservative measures failed to reverse his condition. Despite the successful surgery, he passed away a few weeks later from pneumonia.

Of the 15 emergency surgeries (Table 5), laparotomy was performed in 12 patients: six had perforated hollow viscus, four had unresolving intestinal obstruction that were due to the dense tuberculous adhesions or intestinal strictures, and the remaining two had acute abdomen. Another two patients underwent appendicectomy, while the last patient underwent incision and drainage for an abscess.

In our series, the mortality rate was 29.8%. The majority (15 patients) died from disseminated TB, pneumonia, or end-stage renal failure. The other two mortalities were direct consequences of their surgical conditions. The first was a 68-year-old gentleman with perforation of the terminal ileum that required emergency bowel resection;

he succumbed to septic shock from peritoneal contamination 2 days later. The other was a 37-year-old woman who underwent emergency right hemicolectomy for intestinal obstruction. This was complicated by anastomotic dehiscence on the fifth postoperative day. She also succumbed to septic shock subsequently.

Discussion

TB is seeing a resurgence in recent years due to the increased prevalence of HIV infection.[1,2] HIV is present in up to 50% of patients with TB in developing countries,[14] while patients with HIV are 11 times more likely to develop TB infection.[15] The situation in developed countries is seemingly better with the prevalence of HIV in patients with TB ranging from 9% to 25%.[16,17] However, with

Table 3 Findings of the 50 Patients Who Underwent CT Scans

CT scan findings	Number of patients (%)
Bowel thickening	33 (66.0%)
Mesenteric lymphadenopathy	24 (48.0%)
Ascites	20 (40.0%)
Free gas suggestive of perforation	2 (4.0%)
Splenic involvement	7 (14.0%)
Liver involvement	2 (4.0%)
Pancreatic head mass	2 (4.0%)

Figure 2 CT Scan showing enlarged ileocolic lymph nodes with central caseation (*arrow*).

Table 4 Area of Involvement of Abdominal Tuberculosis

Area of involvement	Number of patients (%)
Gastrointestinal	33 (57.9%)
Duodenum	2 (3.5%)
Jejunum	5 (8.8%)
Ileum	21 (36.8%)
Caecum	16 (28.1%)
Ascending colon and hepatic flexure	12 (21.1%)
Left Colon	5 (8.8%)
Anorectal region	2 (3.5%)
Mesenteric Lymph nodes	24 (42.1%)
Peritoneum	13 (22.8%)
Solid organs	
Spleen	7 (12.3%)
Liver	2 (3.5%)
Pancreas	2 (3.5%)

reporting rates of HIV status among TB patients at between 40% and 70%,[15,16] the rate of HIV infection in TB patients is likely to be much higher.

In Singapore and many developed countries, the incidence of HIV infection is increasing every year.[18] A study done early this year in Singapore on 3,000 leftover blood samples from hospitalized patients, none of whom were known to have HIV, found that one in 350 (0.3%) tested positive for HIV.[19] This has prompted one local hospital to adopt an opt-out HIV testing for all inpatients.

In developed countries, TB has become an index disease to screen for HIV. Some institutions recommend mandatory

Table 5 Types of Surgery Performed

Characteristics	Number of patients (%)
Surgery	
No surgery performed	32 (56.1%)
Surgery performed	25 (43.9%)
Type of elective surgery performed	10 (17.5%)
Laparotomy	4
	3 for suspected malignancy
	1 for intestinal obstruction
Laparoscopy	5
Fistulotomy	1
Type of emergency surgery performed	15 (26.3%)
Laparotomy	12
	6 for perforated hollow viscus (3 Ileum, 2 right colon, 1 duodenum)
	4 for intestinal obstruction
	2 for suspected acute abdomen
Appendicectomy	2
Incision and Drainage of abscess	1

HIV testing of all TB patients in an attempt to control this deadly co-infection.[16,20] It is important to identify undiagnosed HIV patients early as effective anti-retroviral treatment is currently available, and treatment has been shown to decrease the risk of developing TB subsequently.[21]

End-stage renal failure significantly weakens the patient's immunity, and this increases their susceptibility to develop TB as well.[22,23] Diabetes mellitus is one of the most common chronic metabolic disorders in developed countries, and it can lead to end-stage renal failure. TB must always be considered in these patients, especially in the presence of atypical signs and symptoms.

Diagnosis of abdominal TB is often difficult due to the lack of specific symptoms and pathognomonic findings.[24–27] Furthermore, its ability to mimic other inflammatory conditions[9,28] has created one of the greatest diagnostic dilemmas in modern medicine: differentiating between abdominal TB and Crohn's disease. There is much difficulty in distinguishing these two diseases as their clinical presentations, radiological features, operative findings, and even histology can be very similar. However, this step is paramount as inappropriate treatment could aggravate the underlying condition. As inflammatory bowel disease is uncommon in Singapore, anti-tuberculous medications would be started for a presumptive diagnosis of abdominal TB. In contrast, corticosteroids would be administered in the Western countries due to the prevalence of Crohn's disease.

Besides Crohn's disease, caecal malignancy has been confused with ileocaecal TB.[28,29] Both conditions can present with strictures, ulcerations, polyps, lymphadenopathy, and bowel wall thickening.[9,27] Even histological and/or microbiological confirmation may not accurately distinguish these two entities as they can coexist in the same patient.[30–32]

Gastrointestinal TB can result in significant hemorrhage.[33–36] Ulceration and erosions can occur in areas from the stomach to the rectum resulting in bleeding. Diagnosis is often obtained after endoscopic evaluation and biopsy of the affected areas. However, we did not have such a case in our series.

Mimicry of other gastrointestinal malignancies by abdominal TB is not uncommon. Two of our patients almost underwent Whipple's procedure for suspected pancreatic cancer.[37,38] Other neoplastic conditions often confused with abdominal TB included gastrointestinal stromal tumor and esophageal and liver cancer.[9,39,40]

CT scan was the most common imaging modality used in our series. Radiologic features suggestive of abdominal TB include bowel wall thickening, mesenteric lymphadenopathy, ascites, and abscess.[41,42] Although these findings are nonspecific, diagnosis of abdominal TB requires a high index of suspicion in the immuno-compromised and those with previous pulmonary TB.

The gastrointestinal tract, mesenteric lymph nodes, and peritoneum are the most common sites of involvement.[9,27,43] Terminal ileum and caecum are frequently involved within the gastrointestinal tract due to the abundance of lymphoid tissue, physiologic stasis and high rate of absorption.[27,43,44]

Surgery is aimed at achieving the diagnosis and managing the numerous complications such as perforation, bowel obstruction and hemorrhage. Studies have shown that up to 75% of these patients undergo surgery.[43–45] In our series, the corresponding figure was 43.9%. Surgery should be avoided unless absolutely necessary as many patients do poorly after surgery. There are a few reasons for this. Firstly, these patients are usually chronically ill and malnourished, making them poor surgical candidates. Secondly, the questionable or positive HIV status among these patients is another major consideration. Thirdly, appropriate therapy such as intravenous nutritional support, percutaneous drainage of abdominal collections, and empirical anti-tuberculous therapy may resolve the acute presentation, thereby avoiding surgery.[46–48]

Laparoscopy has been advocated as the ideal method in achieving definitive diagnosis in patients with suspected abdominal TB. The accuracy of achieving diagnosis of TB was reported to be over 85%.[49–51] Other than allowing direct evaluation of the peritoneum and intra-abdominal contents, laparoscopy enables the procurement of sufficient tissue for histological and microbiological examination. The advantages of laparoscopy over laparotomy include shorter hospitalization, reduced pain and analgesic usage, and better cosmetic result and may even reduce the incidence of postoperative adhesions.[52,53] However, laparoscopy should be avoided in patients with significant adhesion for risk of perforation.

Conclusion

The mode of presentation and sites of involvement of abdominal TB vary widely and are unpredictable. Although medical treatment remains the mainstay of therapy in TB, emergency surgery is still often required for its acute complications, while elective surgery may be required to resolve atypical presentations. The morbidity of surgery remains high due to the associated immuno-compromised states and its complications. The role of laparoscopy will continue to evolve and is expected to be more prominent in the management of abdominal TB.

References

1. WHO. *Tuberculosis Facts*. 2007. http://www.who.int/tb/publications/2007/factsheet_2007.pdf

2. Wagner KR, Bishai WR. Issues in the treatment of *Mycobacterium tuberculosis* in patients with human immunodeficiency virus infection. AIDS 2001;15:S203–S212. doi:10.1097/00002030-200100005-00024.

3. Aston NO. Abdominal tuberculosis. World J Surg 1997;21 (5):492–499. doi:10.1007/PL00012275.

4. Uygur-Bayramicli O, Dabak G, Dabak R. A clinical dilemma: abdominal tuberculosis. World J Gastroenterol 2003;9(5):1098–1101.

5. Rosengart TK, Coppa GF. Abdominal mycobacterial infections in immunocompromised patients. Am J Surg 1990;159:125–130. doi:10.1016/S0002-9610(05)80617-8.

6. Jadvar H, Mindelzun RE, Olcott EW, Levitt DB. Still the great mimicker: abdominal tuberculosis. Am J Roentgenol 1997;168:1455–1460.

7. Pereira JM, Madureira AJ, Vieira A, Ramos I. Abdominal tuberculosis: imaging features. Eur J Radiol 2005;55(2):173–180. doi:10.1016/j.ejrad.2005.04.015.

8. Uzunkoy A, Harma M, Harma M. Diagnosis of abdominal tuberculosis: experience from 11 cases and review of the literature. World J Gastroenterol 2004;10(24):3647–3649.

9. Kapoor VK. Abdominal tuberculosis. Postgrad Med J 1998;74 (874):459–467.

10. Leder RA, Low VH. Tuberculosis of the abdomen. Radiol Clin North Am 1995;33:691–705.

11. Suri S, Gupta S, Suri R. Computed tomography in abdominal tuberculosis. Br J Radiol 1999;72:92–98.

12. Demirkazik FB, Akhan O, Ozmen MN, Akata D. US and CT findings in the diagnosis of tuberculous peritonitis. Acta Radiol 1996;37:517–520.

13. Balthazar EJ, Gordon R, Hulnick D. Ileocecal tuberculosis: CT and radiologic evaluation. Am J Roentgenol 1990;154:499–503.

14. van Cleeff MR, Chum HJ. The proportion of tuberculosis cases in Tanzania attributable to human immunodeficiency virus. Int J Epidemiol 1995;24(3):637–642. doi:10.1093/ije/24.3.637.

15. Range N, Ipuge YA, O'Brien RJ, Egwaga SM, Mfinanga SG, Chonde TM et al. Trend in HIV prevalence among tuberculosis patients in Tanzania, 1991–1998. Int J Tuberc Lung Dis 2001;5 (5):405–412.

16. Centers for Disease Control and Prevention (CDC). Reported HIV status of tuberculosis patients—United States, 1993–2005. MMWR Morb Mortal Wkly Rep 2007;56(42):1103–1106.

17. Marshall BG, Mitchell DM, Shaw RJ, Marais F, Watkins RM, Coker RJ. HIV and tuberculosis co-infection in an inner London hospital—a prospective anonymized seroprevalence study. J Infect 1999;38(3):162–166. doi:10.1016/S0163-4453(99)90244-X.

18. UNAIDS. AIDS epidemic update. 2007. http://data.unaids.org/pub/EPISlides/2007/2007_epiupdate_en.pdf.

19. Lim MK. HIV testing. *Health Policy Monitor*, October 2007. http://www.hpm.org/survey/sg/a10/3.

20. Moszynski P. Patients with tuberculosis in poor countries must be tested for HIV. BMJ 2007;334(7595):659. doi:10.1136/bmj.39167.337616.DB.

21. Muga R, Ferreros I, Langohr K, de Olalla PG, Del Romero J, Quintana M, Spanish Multicenter Study Group of Seroconverters (GEMES) et al. Changes in the incidence of tuberculosis in a cohort of HIV-seroconverters before and after the introduction of HAART. AIDS 2007;21(18):2521–2527.

22. Elliott AM, Halwiindi B, Hayes RJ, Luo N, Mwinga AG, Tembo G et al. The impact of human immunodeficiency virus on response to treatment and recurrence rate in patients treated for tuberculosis: two-year follow-up of a cohort in Lusaka, Zambia. J Trop Med Hyg 1995;98(1):9–21.

23. Chau TN, Leung VK, Wong S, Law ST, Chan WH, Luk IS et al. Diagnostic challenges of tuberculosis peritonitis in patients with

and without end-stage renal failure. Clin Infect Dis 2007;45 (12):141–146. doi:10.1086/523727.

24. Malik GH, Al-Harbi AS, Al-Mohaya S, Al-Khawajah H, Kechrid M, Al Hassan AO et al. Eleven years of experience with dialysis associated tuberculosis. Clin Nephrol 2002;58(5):356–362.

25. Haddad FS, Ghossain A, Sawaya E, Nelson AR. Abdominal tuberculosis. Dis Colon Rectum 1987;30:724–735. doi:10.1007/BF02561699.

26. McGee GS, Lester WF, Potts J et al. Gastrointestinal tuberculosis resurgence of an old pathogen. Am Surg 1989;55:16–19.

27. Rasheed S, Zinicola R, Watson D, Bajwa A, McDonald PJ. Intra-abdominal and gastrointestinal tuberculosis. Colorectal Dis 2007;9 (9):773–783. doi:10.1111/j.1463-1318.2007.01337.x.

28. King HC, Voss EC Jr. Tuberculosis of the cecum simulating carcinoma. Dis Colon Rectum 1980;23(1):49–53. doi:10.1007/BF02587201.

29. Gadwood KA, Bedetti CD, Herbert DL. Colonic tuberculosis mimicking annular carcinoma: report of a case. Dis Colon Rectum 1981;24(5):395–398. doi:10.1007/BF02603427.

30. Gopal SV, Panda S, Kadambari D, Srinivasan K. Carcinoma colon associated with tuberculosis: an unusual presentation. Int J Colorectal Dis 2007;22(7):843–844. doi:10.1007/s00384-005-0783-9.

31. Isaacs P, Zissis M. Colonic tuberculosis and adenocarcinoma: an unusual presentation. Eur J Gastroenterol Hepatol 1997;9(9):913–915.

32. Kaushik R, Sharma R, Attri AK. Coexisting tuberculosis and carcinoma of the colon: a report of two cases and a review of the literature. Trop Gastroenterol 2003;24(3):137–139.

33. Goudarzi HA, Mason LB. Fatal rectal bleeding due to tuberculosis of the cecum. JAMA 1982;247(5):667–668. doi:10.1001/jama.247.5.667.

34. Weissman D, Gumaste VV, Dave PB, Keh W. Bleeding from a tuberculous gastric ulcer. Am J Gastroenterol 1990;85(6):742–744.

35. Sahoo D, Mahapatra MK, Salim S. Rectal tuberculosis: a rare case. Trop Gastroenterol 2004;25(2):84–85.

36. Monkemuller KE, Lewis JB Jr. Massive rectal bleeding from colonic tuberculosis. Am J Gastroenterol 1996;91(7):1439–1441.

37. Wu CS, Wang SH, Kuo TT. Pancreatic tuberculosis mimicking pancreatic head carcinoma: a case report and review of the literature. Infection 1994;22(4):287–289. doi:10.1007/BF01739920.

38. Claro I, Leitão CN, Oliveira P, Correia J, da Costa JD, Almeida JM et al. Tuberculous mesenteric lymphadenitis mimicking pancreatic carcinoma. Hepatogastroenterology 1996;43(12):1653–1655.

39. Kim YS, Moon JS, Lee JW, Kim I, Ryu SH, Paik IW. Solitary intra-abdominal tuberculous lymphadenopathy mimicking duodenal GIST. Korean J Intern Med 2005;20(1):72–75.

40. Brookes MJ, Field M, Dawkins DM, Gearty J, Wilson P. Massive primary hepatic tuberculoma mimicking hepatocellular carcinoma in an immunocompetent host. Med Gen Med 2006;8(3):11.

41. Pereira JM, Madureira AJ, Vieira A, Ramos I. Abdominal tuberculosis: imaging features. Eur J Radiol 2005;55(2):173–180. doi:10.1016/j.ejrad.2005.04.015.

42. Vanhoenacker FM, De Backer AI, Op DB et al. Imaging of gastrointestinal and abdominal tuberculosis. Eur Radiol 2004;14:103–115.

43. Klimach OE, Ormerod LP. Gastrointestinal tuberculosis: a retrospective review of 109 cases in a district general hospital. Q J Med 1985;56:569–578.

44. Sherman S, Rohwedder JJ, Ravikrishnan KP et al. Tuberculous enteritis and peritonitis: report of 36 general hospital cases. Arch Intern Med 1980;140:506–508. doi:10.1001/archinte.140.4.506.

45. Gilinsky NH, Marks IN, Kottler RE et al. Abdominal tuberculosis: a 10-year review. S Afr Med J 1983;64:849–857.

46. Anand BS, Nanda R, Schdev GK. Response of tuberculous stricture to antituberculous treatment. Gut 1988;29:62–69. doi:10.1136/gut.29.1.62.

47. Clarke DL, Thomson SR, Bissetty T, Madiba TE, Buccimazza I, Anderson F. A single surgical unit's experience with abdominal tuberculosis in the HIV/AIDS era. World J Surg 2007;31(5):1087–1096. doi:10.1007/s00268-007-0402-8.

48. Horvath KD, Whelan RL. Intestinal tuberculosis: return of an old disease. Am J Gastroenterol 1998;93(5):692–696. doi:10.1111/j.1572-0241.1998.207_a.x.

49. Wolfe JHN, Behn AR, Jackson BT. Tuberculous peritonitis and the role of diagnostic laparoscopy. Lancet 1979;1(8121):852–853. doi:10.1016/S0140-6736(79)91266-2.

50. Apaydin B, Paksoy M, Bilir M, Zengin K, Saribeyoglu K, Taskin M. Value of diagnostic laparoscopy in tuberculous peritonitis. Eur J Surg 1999;165(2):158–163. doi:10.1080/110241599750007360.

51. Al Quorain AA, Satti MB, al Gindan YM, al Ghassab GA, al Freihi HM. Tuberculous peritonitis: the value of laparoscopy. Hepatogastroenterology 1991;38:37–40.

52. Jorgensen JO, Lalak NJ, Hunt DR. Is laparoscopy associated with a lower rate of postoperative adhesions than laparotomy? A comparative study in the rabbit. Aust N Z J Surg 1995;65:342–344. doi:10.1111/j.1445-2197.1995.tb00651.x.

53. Schippers E, Tittel A, Ottinger A, Schumpelick V. Laparoscopy versus laparotomy: comparison of adhesion formation after bowel resection in a canine model. Dig Surg 1998;15:145–147. doi:10.1159/000018608.