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ABOUT COVER

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The primary aim of *World Journal of Clinical Cases* (WJCC, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

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Myocarditis as an extraintestinal manifestation of ulcerative colitis: A case report and review of the literature

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Abstract

BACKGROUND

Although extraintestinal manifestations of inflammatory bowel disease (IBD) are well documented, myocarditis has only rarely been reported as an extraintestinal manifestation, and it can be fatal. The various clinical presentations and causes of myocarditis in IBD patients complicate making a correct and timely diagnosis.

CASE SUMMARY

Here we report a 15-year-old boy who presented with myocarditis as the initial presentation of a relapse of ulcerative colitis. In reviewing the literature for cases of myocarditis complicating IBD, we found 21 other cases, allowing us to expand our understanding of the clinical presentation, diagnosis, management, and outcomes of this rare condition. The most frequent diagnostic clues for myocarditis in IBD patients are dyspnea, chest pain, tachycardia, raised cardiac biomarkers, and abnormalities on trans-thoracic echocardiography. Additionally, we discuss the etiology of myocarditis in IBD patients, which include an extraintestinal manifestation, the adverse effects of mesalamine and infliximab, selenium deficiency, and infection, to help provide a framework for diagnosis and management.

CONCLUSION

Myocarditis as an extraintestinal manifestation of IBD can be life-threatening. Trans-thoracic echocardiogram and cardiac magnetic resonance may assist its diagnosis.

Key Words: Inflammatory bowel disease; Myocarditis; Ulcerative colitis; Crohn's disease; Extraintestinal manifestation; Case report

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Core Tip: While the extraintestinal manifestations (EIM) of inflammatory bowel disease (IBD) are well documented, myocarditis as an EIM of IBD is rare. Here we present the case of a 15-year-old boy who presented with myocarditis as the initial presentation of a relapse of ulcerative colitis. The case was unusual in that: (1) While the gastrointestinal symptoms were mild, the endoscopic severity was severe; and (2) He only had mild cardiac symptoms and minimal ventricular dysfunction except for acute chest pain. We therefore propose that cardiovascular manifestations of IBD may be more common than clinically documented, since they may remain undiagnosed.

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INTRODUCTION

The inflammatory bowel diseases (IBD) Crohn's disease (CD) and ulcerative colitis (UC) are chronic, relapsing, inflammatory intestinal disorders. The prevalence of IBD is predicted to reach 0.12%-0.26% in Asia and Latin America and 1% in Western countries over the next 30 years[1]. IBD mainly affects the gastrointestinal tract but is also associated with various extraintestinal manifestations (EIMs), most commonly of the skin, eyes, joints, biliary tract, and lungs[2]. Cardiovascular EIMs, especially myocarditis, are uncommon[3]. Nevertheless, IBD patients are at higher risk of myocarditis than the general population *via* three different mechanisms[4,5]: EIMs, infection, and the side-effects of therapies such as 5-aminosalicylic acid (5-ASA), biological agents, total parenteral nutrition (TPN), and colectomy. Although therapy-related side effects are well-documented[6], myocarditis as an EIM has received little attention even though its diagnosis can be challenging.

Here we present the case of an adolescent boy who developed myocarditis as an EIM of IBD. To provide a framework for the diagnosis and management of myocarditis occurring in this setting, we searched the PubMed database with the keywords “((inflammatory bowel diseases) OR (Crohn's disease) OR (ulcerative colitis)) AND myocarditis”. We found 21 similar cases and summarized the clinical features of myocarditis as an EIM.

CASE PRESENTATION

Chief complaints

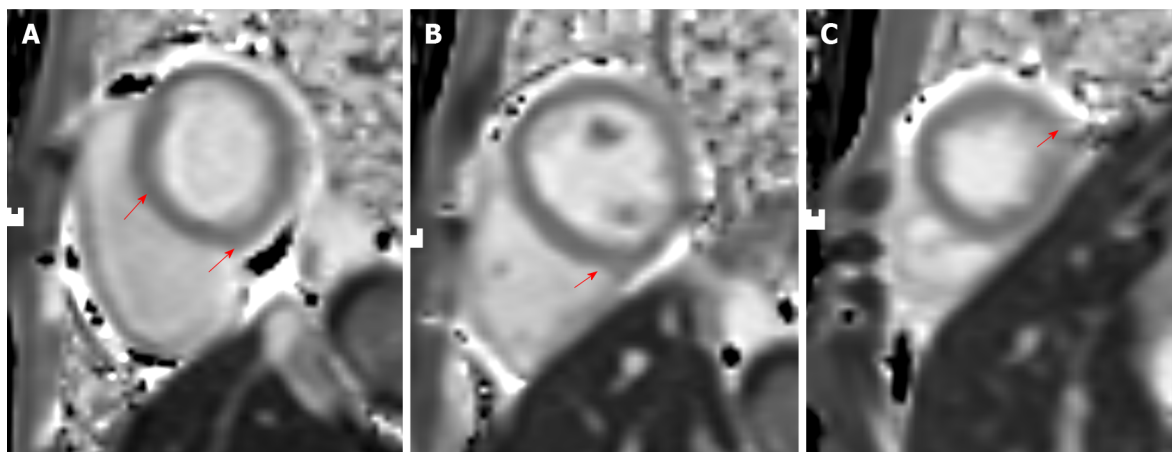
A 15-year-old boy presented to our department with a 5-d history of fever (37.8-38.6 °C) and chest pain.

History of present illness

The boy had a 2-year history of histologically-proven extensive UC, for which mesalamine was effective to achieve remission without adverse reactions. Two weeks prior to presentation, he experienced 7-8 bloody stools per day after eating ice cream, at which time he had been taking mesalamine (3 g/d) as maintenance therapy for a year. Given a likely gastrointestinal infection, cefixime (0.2 g/d) was added. His diarrhea and bloody stools improved quickly from 7-8 times a day to twice a day, which confirmed our diagnosis of infection. However, without any antibiotic changes, he developed modest fever, progressive pleuritic chest pain, and shortness of breath after activity.

History of past illness

The patient had not received any coronavirus disease 2019 vaccinations.



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Figure 1 Cardiac magnetic resonance imaging T1 mapping showing diffuse elevated T1 values. A: Basal segment; B: Middle segment; C: Apical segment.

Personal and family history

There was no personal nor familial history of cardiac abnormality or dysfunction.

Physical examination

On admission, the patient's vital signs were stable and general examination was unremarkable.

Laboratory examinations

A 12-lead electrocardiogram (ECG) demonstrated sinus tachycardia of 102 bpm without other abnormalities. Laboratory tests revealed raised cardiac biomarkers [cardiac troponin I (cTnI) 1.27 ng/mL, N-terminal (NT)-pro hormone brain natriuretic peptide (BNP) 303 pg/mL], and acute phase reactants [high-sensitivity C-reactive protein (hsCRP) 64.7 mg/L and erythrocyte sedimentation rate (ESR) 67 mm/h]. Other myocardial enzymes, including lactate dehydrogenase 121 U/L and creatine kinase MB (CKMB) isoenzyme 0.8 µg/L, were normal. Complete cell counts were roughly normal, except for slight leukocytosis and anemia (white blood cells $10.9 \times 10^9/L$, neutrophils $9.1 \times 10^9/L$, and hemoglobin 113 g/L).

Imaging examinations

Trans-thoracic echocardiogram (echo) revealed only trace pericardial effusion and a left ventricular ejection fraction of 66%. No hypokinesia or ventricular dilation was seen. Given the clinical presentation in the absence of cardiovascular risk factors, a diagnosis of acute myocarditis was suspected, and the etiology was initially considered to be an infection. He was treated with trimetazidine and potassium and magnesium supplementation. His clinical condition gradually improved, with cTnI decreasing to 0.84 ng/mL over the next 5 d. Cardiac magnetic resonance (CMR) imaging was performed. T1 mapping showed diffuse, slightly elevated T1 values (Figure 1) consistent with probable myocarditis[7].

Further diagnostic work-up

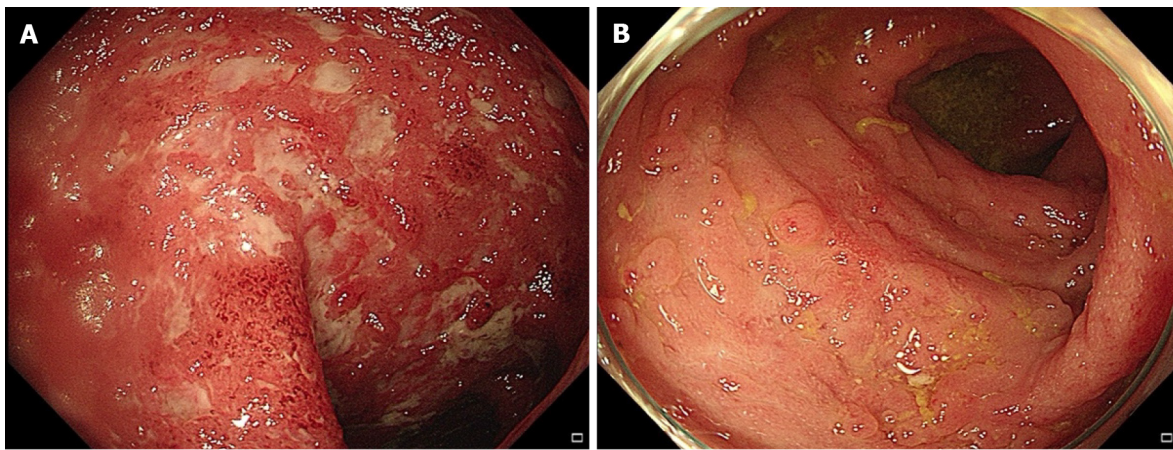
To identify the cause of myocyte injury, stool examination, blood cultures, and extensive viral serology for cytomegalovirus, coxsackie virus, and Epstein-Barr virus were checked and were negative. Endoscopic evaluation of the colon with biopsies revealed active UC (Mayo score 3) involving the colon from the hepatic flexure distally (Figure 2A), although the patient did not describe any worsening of gastrointestinal symptoms.

FINAL DIAGNOSIS

This evidence suggested that the myocarditis was attributable to an EIM of UC.

TREATMENT

The patient was treated with mesalamine (4 g/d) and hydrocortisone (100 mg/12 h), taking the mesalamine continuously during recovery from myocarditis.



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Figure 2 Initial endoscopic appearance of the rectosigmoid junction. A: Extensive ulceration, diffuse erythema, and mucosal edema with loss of vascular markings; B: Endoscopy performed at 3-mo follow-up showing resolved ulceration and pseudopolyps.

OUTCOME AND FOLLOW-UP

The patient's stools became more formed, the chest pain completely resolved, and both cTnI and CRP normalized within 7 d, supporting the diagnosis of inflammatory myocarditis. The patient was referred to the Department of Gastroenterology on oral prednisolone. Then, the prednisolone was tapered down and he was further treated with vedolizumab. His dyspnea and chest pain continued to improve gradually, and his heart rate remained at 70-80 bpm and cTnI returned to normal levels. Three months later, follow-up endoscopy (including biopsies) showed remission of the UC (Mayo score 0-1; Figure 2B).

DISCUSSION

Literature review

Here we present a case of myocarditis as an EIM of IBD. Searching the literature using the PubMed database, we found 21 similar cases (Table 1). Overall, eight of these patients were female and 13 were male and they ranged in age from 11 to 56 years, with an average age of 29 years. Of patients with IBD, ten had CD and eleven UC. The most common symptoms were shortness of breath (12/21), chest pain (10/21), and fever (8/21); tachycardia (11/21) was also frequently noted by patients or clinicians. In ten cases, myocarditis was considered due to the presence of heart failure (HF). Seven developed rapidly progressive symptoms and/or signs of HF within several days, often with cardiogenic shock on admission. The other three reported fatigue and dyspnea at presentation, and two gradually developed further symptoms. In six cases, the initial manifestation of myocarditis was acute coronary syndrome-like, with sudden or worsening chest pain and elevated cardiac biomarkers (*e.g.*, troponin I) with or without ST-segment elevation on ECG. In the absence of angiographic evidence of coronary artery disease and cardiovascular risk factors, myocarditis was suspected based on echocardiographic or CMR findings. Myocarditis presented with unexplained severe arrhythmia and cardiac arrest in three cases, and two had previously had dyspnea.

Myocarditis can also mimic other noninflammatory cardiac disorders. Two cases were initially suspected to be infective endocarditis and pulmonary embolism, but myocarditis was then considered due to serial negative blood cultures and pulmonary artery pressure examination by right cardiac catheterization, respectively. The majority of patients (19/21) did not report cardiovascular comorbidities; only one patient had a history of stress cardiomyopathy and the other had deep venous thrombosis. Six cases reported recurrent myo(peri)carditis, with the recurrence rate in IBD patients significantly higher than in other myocarditis patients[8].

Myocarditis often occurred during the active stage of IBD in most patients (15/21), but it also preceded the gastrointestinal symptoms (3/21) or occurred during the asymptomatic stage (3/21) in others. Cases that were relatively free from gastrointestinal symptoms (5/6) usually had mild symptoms and did not need ventilatory or inotropic support. Of the 21 myocarditis patients, 11 were confirmed by histopathological examination or CMR features fulfilling the updated Lake Louise criteria[9]. The remaining ten patients were possible cases where the authors reported a diagnosis of myocarditis through supporting laboratory test results, 12-lead ECG, or echocardiographic features. Laboratory investigations were remarkable for elevated white cell count, acute phase reactants (*e.g.*, CRP and ESR), and cardiac biomarkers (*e.g.*, cTnI, BNP, and CKMB) in most (though not all) cases.

Table 1 Summary of reported cases describing myocarditis as an extraintestinal manifestation of inflammatory bowel disease

Ref.	Sex/age	IBD type	Diagnosis	Clinical presentation	Testing	Myocarditis treatment	Outcome	Recurrence/other info
Frid <i>et al</i> [22], 1986	Male/11	CD	Myocarditis	Fever (38 °C), fatigue, dyspnea on exertion	Raised ESR; ST-segment depression (ECG)	Steroids	Improved	EIM earlier than GI symptoms
Weiss <i>et al</i> [23], 1995	Male/44	CD	Myocarditis	Fatigue, dyspnea on exertion symptoms of congestive heart failure	WBC 15.2, ESR 64, CRP 64.2; ST-T segment flattening (ECG); cardiomegaly (CXR); LVEF 30%, left heart enlargement with regional hypokinesia (echo)	Steroids + olsalazine	Improved	Subcutaneous granulomas; EIM earlier than GI symptom
Hyttinen <i>et al</i> [24], 2003	Female/37	CD	Myopericarditis	Chest pain, palpitations, dyspnea on exertion loss of consciousness, convulsions	CRP 149; third-degree AV block, ST-segment elevation T-wave inversion (ECG); pericardial effusion (echo); normal (EMB)	Atropine + PPM	Improved	5 × recurrences; GI symptom (-)
Nishtar <i>et al</i> [25], 2009	Female/21	CD	Myocarditis	Fever (37.5 °C), dyspnea, symptoms of pulmonary edema, hemodynamically unstable	WBC 21, CRP 234; TnI 0.48; diffuse T-wave inversion (ECG); pulmonary edema (CXR); LVEF 16%, dilation of ventricles with global hypokinesia (echo)	ICU + ventilatory and inotropic support mesalamine	Improved	After limited hemicolectomy
Sikkens <i>et al</i> [26], 2010	Male/46	CD	Myopericarditis	Fever (38.5 °C), tachypnea cardiac arrest	WBC 12, ESR 22; unremarkable ventricular fibrillation (ECG); lymphocytic infiltration (autopsy)	CPR	Died	
Williamson and Dalton[27], 2011	Male/18	CD	Myocarditis	Shock, tachypnea, hypoxic	Raised CRP; pulmonary edema (CXR); RBBB LVEF 20%, LV failure (echo)	Subtotal colectomy + ventilatory and inotropic support	Improved	
Oh <i>et al</i> [28], 2012	Female/19	CD	Myocarditis	Fever (41.0 °C), headache, myalgia impaired consciousness, shock, respiratory failure	WBC 21.44, CRP 92.9; TnI 5.32; sinus tachycardia (ECG); pulmonary edema (CXR); LVEF 38%, dilation of ventricles with LV regional akinesia (echo)	ICU + inotropic support steroid + mesalamine	Improved	
Belin <i>et al</i> [29], 2016	Female/56	CD	Myocarditis	Pleuritic chest pain radiating to the back and shoulders	WBC 13.7, ESR 47, CRP 22.7; TnI 1.14-1.63, BNP 166; LV hypertrophy (ECG); pleural effusion (CXR); LVEF 45-50%, regional hypokinesia (scho); regional DGE, elevated ECV (CMR)	Infliximab steroids	Improved	
Kumar <i>et al</i> [30], 2019	Male/37	CD	Myopericarditis	Pleuritic chest pain, dry cough, fever (38.1 °C)	WBC 26.2, ESR 121, CRP 180.1; TnI 1.82; ST-segment elevation (ECG); regional EGE and DGE with edema (CMR)	Steroids + colchicine	Improved	P.M. stress cardiomyopathy
McGrath-Cadell <i>et al</i> [31], 2020	Female/27	CD	Myopericarditis	Pleuritic chest pain, fever (39 °C), dyspnea, hemodynamically unstable	WBC 21, CRP 115; TnI 9; T-wave inversion (ECG); regional thickening and hypokinesia, mobile valvular masses (echo); focal edema with DGE (CMR)	Steroids + colchicine + AZA	Improved	2 × recurrences; P.M. monocular visual loss and sterile splenic abscesses; GI symptoms (-)
Mowat <i>et al</i> [32], 1974	Male/15	UC	Myopericarditis	Retrosternal discomfort, fever	Raised ESR; sinus tachycardia, ST-segment abnormality, T-wave inversion (ECG)	Steroids + sulphasalazine	Improved	4 × recurrences; renal calculus
McKeon <i>et al</i> [33], 1986	Female/17	UC	Myocarditis	Cardiac arrest, hypotensive, peripheral edema	Pleural effusion (CXR); sinus tachycardia with incomplete RBBB tachyarrhythmias	ICU + inotropic support	Died	After total colectomy, PTN

					(ECG); LVEF 23%, RV dilation (echo); giant cell collection (autopsy)			
Frid <i>et al</i> [22], 1986	Male/19	UC	Myocarditis	Fatigue, dyspnea heart failure, arrhythmia	ESR 10; cardiomegaly, pleural effusion (CXR); heart little movement (echo)	ICU + steroids	Improved	Urticaria; GI symptoms (-)
Stajer and Gorjup [34], 1996	Female/17	UC	Myopericarditis	Chest pain, tachycardia, dyspnea, hypotensive, hypoxic, enlarged liver and spleen	ESR 72; S1Q3, R-wave progression (ECG); cardiomegaly, bilateral effusion (CXR); pericardial effusion, RV enlargement (echo)	ICU + mesalamine	Improved	Pleuritis, DVT
Nash <i>et al</i> [35], 2001	Male/46	UC	Myocarditis	Chest pain, tachycardia, hypotensive, tachypnea; gallop rhythm, hepatojugular reflux (+)	WBC 18.6; ST-segment elevation (ECG); LVEF 19%, global hypokinesia (echo); giant cells with necrosis (EMB)	ICU + inotropic support + IABP + steroids + immunoglobulin + CsA + etanercept + AZA	Died	P.M. ITP
Freeman and Salh [36], 2010	Male/26	UC	Myopericarditis	Pleuritic chest pain radiating to the shoulder and neck, fever, tachycardia, lethargy	WBC normal; TnI 4.82; atrial flutter with 2:1 block non-specific ST-T wave change (ECG)	Steroids + mesalamine	Improved	2 × recurrences, EIM before GI symptoms
Varnavas <i>et al</i> [37], 2014	Male/30	UC	Myocarditis	Symptoms of left heart failure	WBC 16.3, CRP 276; TnI 7.6, BNP 4745; sinus tachycardia, non-specific ST-T wave changes (ECG); LVEF 13%, regional hypokinesia, pericardial effusion (echo); focal edema (CMR); lymphocytic infiltration (EMB)	ICU + inotropic support + IABP + steroids + mesalamine	Improved	2 × recurrences
Gruenhagen <i>et al</i> [38], 2014	Male/24	UC	Myocarditis	Chest pain radiating to the arms, dyspnea, diaphoresis, dizziness	TnI 0.211-1.57 (ref < 0.034); ST-segment elevation (ECG); DGE (CMR)	Ssteroid + mesalamine	Improved	
Kim <i>et al</i> [39], 2016	Female/28	UC	Myocarditis	Dyspnea	TnI 0.512; sinus tachycardia, non-specific ST-segment change (ECG); cardiomegaly, pulmonary congestion (CXR); LVEF 33%, LV hypokinesia and dilation (echo)	ECMO + steroid + infliximab	Improved	
Murphy <i>et al</i> [40], 2017	Male/42	UC	Myocarditis	Symptoms of heart failure	BNP 4987; non-specific T-wave changes (ECG); pulmonary edema, pleural effusion (CXR); LVEF 29%, LV global hypokinesia, pericardial effusion (echo); focal DGE (CMR); eosinophilic infiltration, fibrosis (EMB)	Steroids + ICD	Improved	
Caio <i>et al</i> [41], 2021	Male/26	UC	Myocarditis	Chest pain, tachycardia	WBC 15.2, CRP 32.1; raised TnI; normal (ECG); focal edema (CMR)	Steroids + vedolizumab	Improved	2 × recurrences

CD: Crohn's disease; UC: Ulcerative colitis; WBC: White blood cell ($\times 10^9/L$); CRP: C-reactive protein; ESR: Erythrocyte sedimentation rate; TnI: Cardiac troponin I; BNP: Brain natriuretic peptide; ECG: Electrocardiogram; RBBB: Right bundle branch block; CXR: Chest radiograph; echo: Echocardiography; LVEF: Left ventricular ejection fraction; CMR: Cardiovascular magnetic resonance; EGE: Early gadolinium enhancement; DGE: Delayed gadolinium enhancement; ECV: Extracellular volume; EMB: Endomyocardial biopsy; PPM: Permanent pacemaker; ICD: Implantable cardioverter-defibrillator; IABP: Intra-aortic balloon pump; AZA: Azathioprine; CsA: Cyclosporin A; CPR: Cardiac pulmonary resuscitation; GI symptoms: Gastrointestinal symptoms; EIM: Extraintestinal manifestation; ITP: Immune thrombocytopenic purpura; DVT: Deep venous thrombosis; TPN: Total parenteral nutrition; IBD: Inflammatory bowel disease; ICU: Intensive care unit; P.M.: Past medical history.

In 19 reported ECGs, except for sinus tachycardia, ST-T changes in the form of ST-segment elevation (4), depression (1), or flattening (1); non-specific ST-T wave changes (3); and T-wave inversion (4) were frequently noted. Arrhythmias and conduction block (4) were also observed. Three cases reported roughly normal ECGs. Fourteen cases reported echo findings which were all abnormal, mainly focal or global hypokinesia (11), low ejection fraction (10), ventricular dilation or enlargement (6), and accumulation of pericardial fluid (4). Abnormal findings on chest radiograph were reported in ten cases and included pleural effusion (5), pulmonary edema (4), and cardiomegaly (4).

Endomyocardial biopsies (EMB) were reported in four cases. Together with the autopsy results in two other cases, myocarditis as an EIM presented with three histopathological patterns: (1) Giant cell myocarditis (2); (2) Lymphocytic myocarditis (2); and (3) Eosinophilic myocarditis (1). No abnormalities were found in one patient. In ten cases published after 2010, seven patients were assessed by CMR. Six showed both edema and delayed gadolinium enhancement on CMR, verifying the diagnosis of myocarditis; only one reported tissue edema. Pericardial effusion and hypokinesia were also mentioned. Myocardial lesions in IBD patients mainly involved the lateral free wall (5), consistent with the general characteristics of myocarditis[10], and two cases reported injury of the interventricular septum.

All cases reported treatment and outcomes. The treatment of myocarditis as an EIM can be divided into two main approaches: Immunosuppressive therapy and guideline-directed HF (and/or arrhythmia) therapy. Fifteen cases were given corticosteroids, and four were also prescribed a tumor necrosis factor-alpha inhibitor; two cases only used mesalamine. Nine patients were treated with advanced cardiopulmonary support, including mechanical ventilation, inotropic support, intra-aortic balloon pump, and extracorporeal membrane oxygenation, mainly due to rapidly progressive HF. Two cases received cardiac implantable electronic devices. Eighteen cases reported symptomatic improvement at subsequent follow-up visits. Histopathological examination of three deaths showed giant cell myocarditis (2) and lymphocytic myocarditis (1). The former is associated with a worse prognosis, as suggested previously[11]. Contrary to the histological deterioration, two patients showed symptom remission before death, suggesting that repeat EMB to monitor responses to therapy is necessary.

Discussion

Myocarditis is a heterogeneous and insidious disease that can mimic other cardiovascular disorders. The incidence rate ratio for developing myocarditis is 8.3-times for CD and 2.6-times for UC compared with the background population[4]. Therefore, early diagnosis and treatment of myocarditis to avoid potentially life-threatening outcomes in IBD patients are essential. Myocarditis as an EIM of IBD is associated with various clinical patterns ranging from subclinical symptoms to sudden death. The initial symptoms of myocarditis are easily overlooked, including shortness of breath, palpitations, chest pain, and fever. When seeking medical advice, most of the cases presented in this review developed critical cardiac symptoms such as aggregated symptoms of HF, acute myocardial infarction-like syndrome, or severe arrhythmia.

As for auxiliary examinations, 12-lead ECG, routine laboratory studies, and trans-thoracic echocardiography are all used in the initial assessment of suspected cardiac diseases. There was no uniform pattern found on ECG in IBD patients with myocarditis, with the abnormalities reported including sinus tachycardia, ST-T changes, and arrhythmias. Myocarditis also causes non-specific elevation of inflammatory markers and cardiac troponins. Given that the former is often increased during episodes of IBD, the dynamics of biomarker changes are more important in these patients. Since patients with myocarditis were more likely to present with a syndrome of HF, echocardiography has sufficiently high sensitivity to evaluate ventricular function and diagnose HF and it should be performed in all patients with suspected myocarditis. The presence of hypokinesia, a low ejection fraction, ventricular enlargement or dilation, and pericardial effusion raises the likelihood of myo(peri)carditis. EMB is the gold standard diagnostic test for myocarditis. However, due to its invasive nature, EMB is rarely applied in clinical practice and usually only performed in critically ill patients. CMR provides non-invasive characterization of the myocardium as an alternative and is recommended in clinically stable patients prior to EMB[12].

In our case, the patient initially only had mild chest discomfort, fever, and dyspnea during exercise, but this worsened over only a few days without treatment. Thus, health education is important in IBD patients and should include a recommendation to seek medical intervention actively if they experience dyspnea, chest pain, or tachycardia. Our patient presented with acute coronary syndrome-like symptoms of chest pain and raised cardiac troponins and BNP, as well as sinus tachycardia and pericardial effusion on ECG and echo, respectively, which led to the suspicion of myocarditis. The patient did not undergo coronary imaging due to a lack of typical cardiovascular risk factors, similar to other cases in young people presented in this review. Diffuse elevation of T1 values on CMR T1 mapping confirmed myocardial injury, although isolated elevated T1 cannot discriminate between the acute and healed stages of myocarditis[13].

Another challenge in the treatment of myocarditis is identifying the etiology. IBD patients may develop myocarditis due to an EIM of IBD, infection, or the adverse effects of medications. Myocarditis can occur as an EIM in both UC and CD. The pathogenesis of EIMs is incompletely understood, but a popular hypothesis is that they are caused by extension of antigen-specific immune responses from the intestine to extraintestinal sites. Ectopic expression of gut-specific chemokines and adhesion molecules,

gastrointestinal effector T cell trafficking, microbial antigen translocation or cross-reaction, and circulating antibodies may contribute to the process[14]. Infections, especially those caused by enteroviruses, are also a non-negligible cause of myocarditis. Patients with IBD are at increased risk of acquiring infections compared to age-matched patients without IBD. The risk is higher when patients are treated with corticosteroids, immunomodulators, and biologic agents, in particular when treatments are combined[15]. Adverse side effects of medications must also be considered. Mesalamine, a 5-ASA derivative, is recommended as a first-line treatment to induce remission in patients with mild-to-moderate IBD, especially those with ulcerative proctitis[16]. Mesalamine-induced cardiotoxicity can manifest as myocarditis, pericarditis, and pericardial effusion, perhaps *via* an immunoglobulin E-mediated allergic reaction, direct cardiac toxicity, a cell-mediated hypersensitivity reaction, or cross-reaction between antibodies against mesalamine and heart muscle[6]. Myocarditis induced by other treatments such as tumor necrosis factor- α inhibitors, TPN, and colectomy have also been reported[17-19]. The latter two may trigger the disease by reducing selenium concentrations[20].

Our patient developed myocarditis after recovery from a gastrointestinal infection, and the bowel symptoms were under control. While infectious myocarditis was considered at first, blood and stool examinations and viral serology were all negative. Although the correlation between viral serology and myocardial infection is controversial and EMB is the only approach to diagnose viral myocarditis[21], these negative test results did turn our attention to other possible etiologies. There are no specific physical findings, clinical presentations, or laboratory tests that can help confirm the causative role of drugs in myocarditis. The diagnosis of mesalamine-induced myocarditis relies on symptom onset within 2-4 wk of starting the drugs and resolution of symptoms within several days of withdrawal. Presentation may be delayed due to concurrent administration of steroids[6]. In our patient, mesalamine-induced myocarditis was unlikely, since mesalamine was administered over a long duration without steroids and there were no notable previous adverse cardiac events. Subsequent colonoscopy revealed active UC, and myocarditis in association with relapsed UC was diagnosed. Treatment with steroids led to rapid resolution of both cardiac and colonic symptoms, further supporting the diagnosis.

During the improvement in gastrointestinal symptoms, our patient developed acute chest pain, which implied a UC flare as confirmed by colonoscopy. The bloody diarrhea was under control at that time, leading to difficulties in early diagnosis. Furthermore, compared with other cases in this review, he had less myocardial damage. If the chest pain had not deteriorated, the patient would not have seen a doctor. This leads us to suspect that cardiovascular manifestations of IBD may be more common than clinically documented, since they may remain undiagnosed.

CONCLUSION

In conclusion, though rarely reported, myocarditis as an EIM of IBD can be life-threatening without timely diagnosis. Here we reported a 15-year-old boy who developed myocarditis as an initial presentation of relapsing UC. We reviewed other reports of myocarditis complicating IBD. Shortness of breath, chest pain, and tachycardia in IBD patients, even without gastrointestinal manifestations, should raise clinical suspicion of this uncommon association. Our case and the literature review also highlight the utility of trans-thoracic echo and CMR in diagnosing myocarditis.

FOOTNOTES

Author contributions: All authors were involved in the care of the patient. Wang YY and Wang J wrote the initial draft of the manuscript; Shi W, Li Y, Tian Z, and Jiao Y critically appraised and revised the overall content of the manuscript; and all authors read and approved the final manuscript.

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