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RADIATION ENTERITIS AND SURGICAL MANAGEMENT: CURRENT EVIDENCE

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ABSTRACT Radiation enteritis is a significant complication of abdominal and pelvic radiotherapy, leading to acute and chronic gastrointestinal damage. Acute forms present with diarrhea, nausea, and vomiting, while chronic radiation enteritis results in fibrosis, strictures, and malabsorption. Diagnosis relies on clinical history, imaging, endoscopic evaluation, and functional tests. Management includes dietary modifications, pharmacological treatment, and surgical interventions for severe cases. Emerging therapies such as hyperbaric oxygen therapy and biologic agents show potential for improving outcomes. Understanding pathophysiology and optimizing therapeutic strategies remain essential for minimizing complications and enhancing the quality of life in affected patients.

KEYWORDS : Radiation Enteritis, Gastrointestinal Toxicity, Radiotherapy Complications, Intestinal Fibrosis, Bowel Obstruction

INTRODUCTION

Radiation enteritis is a significant complication of abdominal and pelvic radiotherapy, affecting the small intestine and proximal colon. The incidence varies based on radiation dose, fractionation, and patient-specific factors. The pathogenesis involves progressive vascular damage, chronic inflammation, and fibrosis, leading to complications such as strictures, perforations, and malabsorption (1).

Clinical manifestations can be classified into acute and chronic forms. Acute radiation enteritis occurs during or shortly after treatment, presenting with nausea, vomiting, and diarrhea. Chronic radiation enteritis develops months to years later, often with severe complications such as bowel obstruction, gastrointestinal bleeding, and malnutrition (2). Given the impact on patient quality of life, appropriate diagnosis and management are crucial. While medical therapy remains the first line of treatment, surgical intervention becomes necessary in refractory cases with complications like strictures or fistulas.

This article reviews the current evidence on radiation enteritis, focusing on its pathophysiology, diagnosis, and treatment, with particular emphasis on surgical management.

Methods

A comprehensive literature review was conducted using four databases: PubMed, Scopus, Embase, and Web of Science. Search terms included "Radiation Enteritis," "Intestinal Radiation Injury," "Gastrointestinal Toxicity," "Bowel Obstruction," and "Surgical Management." Studies published in the last ten years were considered, prioritizing systematic reviews, clinical trials, and evidence-based guidelines.

Articles were selected based on their relevance to the epidemiology, pathophysiology, diagnostic approach, and treatment options for radiation enteritis. A total of 15 studies were included in this review, ensuring a thorough evaluation of the latest advancements in both conservative and surgical management strategies.

Pathophysiology of Radiation Toxicity

Radiation enteritis results from direct cellular damage and progressive microvascular injury, leading to epithelial dysfunction and impaired intestinal barrier integrity. Ionizing radiation disrupts the gastrointestinal epithelium, triggering apoptosis and reducing regenerative capacity. Additionally, damage to endothelial cells leads to capillary rarefaction, ischemia, and increased intestinal permeability (3).

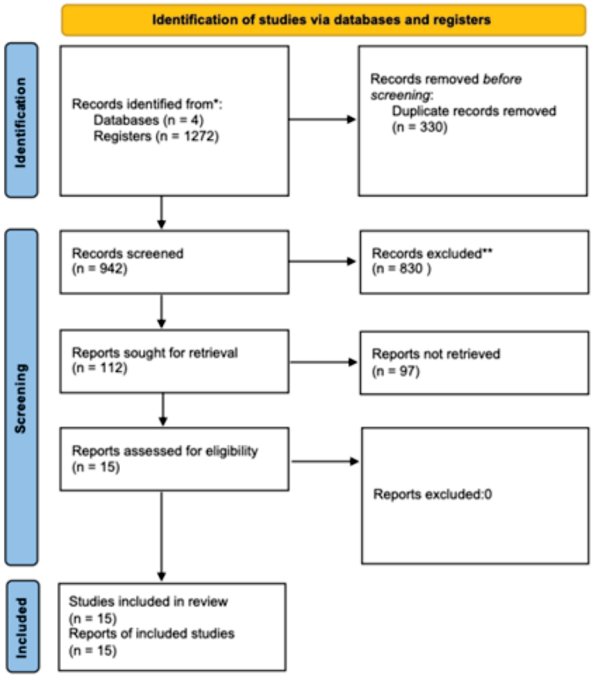

Figure 1. PRISMA

The inflammatory response further exacerbates tissue damage, with immune cell infiltration and the release of pro-inflammatory cytokines, including tumor necrosis factor-alpha (TNF-α) and transforming growth factor-beta (TGF-). Chronic inflammation promotes fibrosis, thickening the intestinal wall and contributing to strictures and motility disorders (3).

Several factors influence an individual's susceptibility to radiation enteritis. Higher radiation doses and fractionation schemes increase the likelihood of chronic complications. Advanced techniques, such as intensity-modulated radiation therapy (IMRT), help mitigate exposure to healthy tissues. However, preexisting comorbidities, including diabetes, vascular diseases, and prior abdominal surgeries, further elevate the risk of developing severe radiation-induced intestinal damage (4).

Classification of Gastrointestinal Toxicity

Acute Toxicity

Acute gastrointestinal toxicity occurs during or shortly after radiation therapy and is primarily caused by direct mucosal injury and inflammation. Symptoms include acute enteritis, nausea, vomiting, diarrhea, and anorexia. These effects result

from epithelial cell apoptosis, loss of mucosal integrity, and increased intestinal permeability, leading to inflammation and compromised nutrient absorption (5). Management includes supportive care with dietary modifications, hydration, and pharmacological interventions such as anti-diarrheal agents and anti-emetics. In most cases, symptoms resolve within weeks after treatment cessation (5).

Chronic Toxicity

Chronic radiation toxicity manifests months to years post-treatment and is associated with progressive fibrosis, vascular damage, and impaired intestinal regeneration. Patients may develop complications such as strictures, ulcerations, gastrointestinal bleeding, bacterial overgrowth, and malabsorption syndromes. The underlying mechanism involves chronic inflammation, ischemic injury due to microvascular changes, and fibrosis leading to luminal narrowing and dysmotility (6). Long-term management strategies focus on symptom control, nutritional support, and, in severe cases, surgical intervention to address strictures or refractory symptoms (6).

Understanding the classification of radiation-induced gastrointestinal toxicity is essential for implementing preventive strategies, early intervention, and optimizing long-term patient care.

Clinical Manifestations

Esophagus: Radiation-induced esophagitis can present acutely with odynophagia and dysphagia, while chronic complications may include esophageal strictures requiring endoscopic dilation (7).

Stomach: Gastric toxicity includes radiation-induced gastritis, ulcer formation, and delayed gastric emptying. Patients may experience epigastric pain, nausea, and early satiety, with long-term risks of chronic gastric atrophy (8).

Small Intestine: Acute enteritis is characterized by diarrhea, abdominal cramping, and fluid loss, while chronic radiation injury may lead to malabsorption, bacterial overgrowth, and strictures, resulting in weight loss and nutrient deficiencies (8).

Colon and Rectum: Radiation proctitis is a common complication, presenting acutely with diarrhea and rectal urgency. Chronic effects may include rectal bleeding, tenesmus, and fistula formation, significantly affecting quality of life (9).

Recognizing these manifestations is crucial for timely diagnosis and appropriate intervention to mitigate long-term complications and improve patient outcomes.

Diagnosis

The diagnosis of radiation enteritis requires a comprehensive clinical evaluation, incorporating patient history, imaging modalities, endoscopic assessment, and functional tests. A thorough medical history should include details regarding prior exposure to abdominal or pelvic radiotherapy, with a correlation of symptoms to the timeline of radiation treatment. This approach helps distinguish between acute and chronic manifestations of the disease (10).

Imaging studies play a fundamental role in the diagnostic process. Computed tomography (CT) and magnetic resonance enterography (MRE) are essential tools for assessing bowel wall thickening, inflammation, and strictures. These modalities aid in differentiating radiation-induced damage from other gastrointestinal disorders, such as inflammatory bowel disease or malignancies (11).

Endoscopic evaluation through colonoscopy or upper gastrointestinal endoscopy allows for direct visualization of characteristic mucosal changes, including telangiectasias, mucosal friability, and fibrosis. Histological analysis of biopsy specimens is crucial in confirming radiation-induced pathology and distinguishing it from other inflammatory or neoplastic conditions (11).

Functional assessments provide additional diagnostic insights. Hydrogen breath tests are valuable in detecting small intestinal bacterial overgrowth, while lactose absorption tests evaluate malabsorption secondary to mucosal injury. These tests are particularly useful in patients experiencing persistent gastrointestinal symptoms following radiotherapy (12).

Differential Diagnosis

The differential diagnosis of radiation enteritis includes several gastrointestinal conditions with overlapping clinical presentations. Inflammatory bowel disease (IBD), particularly Crohn's disease and ulcerative colitis, shares histopathologic and radiologic similarities, necessitating careful differentiation through endoscopic findings and biomarker evaluation. Gastrointestinal infections, including Clostridioides difficile colitis, must also be considered, particularly in immunosuppressed individuals.

Additionally, irritable bowel syndrome (IBS) represents a functional disorder with symptoms that can resemble radiation enteritis in the absence of structural abnormalities. Lastly, radiation-induced gastrointestinal neoplasms, although rare, must be considered in patients with a history of radiotherapy, warranting long-term surveillance and biopsy when necessary (12).

Management and Treatment

The management of radiation enteritis involves a multimodal approach aimed at symptom control, nutritional optimization, and, in severe cases, surgical intervention. Treatment strategies vary depending on the severity of the condition and the presence of complications.

A key component of management is dietary modification. A low-residue diet is recommended to minimize mechanical irritation and reduce the risk of bowel obstruction, particularly in patients with strictures or delayed intestinal transit (1). Additionally, symptomatic control is achieved through the use of antiemetics for nausea, antidiarrheal agents for radiation-induced diarrhea, and probiotics to restore gut microbiota balance (5). Nutritional support should be carefully tailored to individual patient needs, as chronic radiation enteritis often leads to malabsorption and weight loss. In cases of significant nutritional deficiencies, enteral nutrition via feeding tubes or total parenteral nutrition may be required (6).

Treatment is further tailored to specific complications. Chronic diarrhea, often due to bile acid malabsorption, can be managed with bile acid sequestrants such as cholestyramine, which bind excess bile acids and reduce stool frequency (6). In patients with refractory symptoms, other pharmacological options include octreotide, a somatostatin analogue that decreases intestinal secretions, helping to control severe diarrhea (13). Intestinal obstruction is another serious complication, often resulting from radiation-induced fibrosis and stricture formation. In mild cases, a conservative approach involving bowel rest, intravenous fluids, and decompression via nasogastric tubes may suffice. However, in severe cases with complete obstruction, surgical intervention, including resection of fibrotic segments or stricturoplasty, may be necessary (13).

Chronic gastrointestinal bleeding due to radiation-induced telangiectasias can be effectively treated with endoscopic argon plasma coagulation, which offers a minimally invasive method of hemostasis (14). Repeated procedures may be necessary for patients with recurrent bleeding. For patients with extensive radiation damage, surgical options such as segmental bowel resection may be considered, though these

interventions are associated with increased morbidity (14).

Malabsorption is a common consequence of chronic radiation enteritis, often leading to deficiencies in fat-soluble vitamins, iron, and vitamin B12. Patients experiencing severe malabsorption may require oral or intravenous supplementation. In cases of extensive intestinal damage, total parenteral nutrition may be indicated to maintain adequate caloric intake and prevent severe malnutrition (15).

Emerging therapies are being explored to enhance tissue repair and reduce inflammation in radiation enteritis. Hyperbaric oxygen therapy has shown promise in promoting angiogenesis and tissue regeneration by increasing oxygen delivery to irradiated intestinal segments. Studies suggest that this approach may improve mucosal healing and reduce the severity of radiation-induced fibrosis (13). Additionally, the use of anti-inflammatory agents and biologic therapies targeting cytokine-mediated pathways is under investigation to mitigate chronic inflammation and fibrosis. These include agents targeting tumor necrosis factor-alpha (TNF-) and transforming growth factor-beta (TGF-), both of which play central roles in the pathogenesis of radiation enteritis (14).

CONCLUSION

Radiation enteritis remains a challenging complication of radiotherapy, significantly impacting gastrointestinal function and patient quality of life. Early diagnosis and a multidisciplinary approach to management are essential to mitigate symptoms and prevent long-term complications. Advances in imaging, endoscopic therapy, and novel treatment modalities such as biologic agents and hyperbaric oxygen therapy offer promising avenues for improved care. Continued research and individualized treatment strategies are crucial for optimizing outcomes in patients affected by radiation-induced intestinal injury.

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