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Role of Computed Tomography in the Staging and Management of Colorectal Cancer: A Clinical Assessment

Hossam A ElKenawy[1*], Mohammed Ibrahim Alsaeed[2] , Abdulelah Abdulrahman Najmi[3], Abeer Nasser Al Ghalbi[4], Ibrahem Ghaleb Daiwali[5], Ali Hussain Alshuhay[6], Afnan Haled Alotaibi[7], Abdulrahman Khulaif Alharbi[8], Abdulaziz Omair Alshehri[9], Abdulrahman Mahmoud Albahkali[10], Saad Rashed Aldhafyan[10], Nujud Adel Barayan[10], Abdullah Faisal Alnakhli[11], Ali Mohammed Aleid[12]

[1]Department of Radiology, AlHammadi hospital, Riyadh, KSA.
[2] King Abdulaziz hospital – AlAhsa, Saudi Arabia.
[3] Samtah general hospital – Samtah, Saudi Arabia.
[4] Department of family medicine and community medicine, Taif university, Taif, Saudi Arabia.
[5]AL Battarjee college of medicine, Jeddah, Saudi Arabia.
[6] Department of General Surgery, Omran General Hospital, Saudi Arabia.
[7] Department of Radiology, King Abdulaziz hospital Makkah/ resident, Saudi Arabia.
[8] Faculty of Medicine, Qaseem University, King Fahad Specialist Hospital.
[9] Department of emergency, Althager general hospital, Jeddah, Saudi Arabia.
[10] GP, MOH, Riyadh - Saudi Arabia.
[11] Battarjee medical college (bmc), Jeddah, Saudi Arabia.
[12] Medical University Of Lodz, Poland.

***E-mail** ✉ Hossamkenawy28@gmail. Com

Abstract

Colorectal cancer (CRC) ranks among the most prevalent cancers globally, being the third most common type and the fourth leading cause of cancer-related deaths. Its incidence varies across regions, with higher rates observed in developed countries compared to developing ones. CRC is also associated with lower socioeconomic status. This review explores the existing literature on the etiology, diagnosis, and treatment of colorectal cancer. A comprehensive search was conducted across various databases, including PubMed, ScienceDirect, Web of Science, EBSCO, and the Cochrane Library. Studies were screened for inclusion based on titles and abstracts using Rayyan QCRI, followed by full-text assessments. The analysis included 7 trials encompassing a total of 3,134,223 patients with CRC. The majority of diagnoses were made using computed tomography (CT), while one study relied on surgical methods. MRI was also utilized in some of the studies. CT plays an important role in staging CRC, according to the TNM classification (tumor, node, metastasis). Advances in molecular characterization of colon tumors are expected to provide more precise and personalized treatments for people with polyps and cancers, based on specific genetic alterations.

Keywords: Causes, Colorectal cancer, Diagnosis, Staging, Systematic review, Management.

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Introduction

Colorectal cancer (CRC) ranks as the third most frequently diagnosed cancer globally and the fourth leading cause of cancer-related death, with approximately 700,000 fatalities each year. It follows only lung, liver, and stomach cancers in terms of

mortality. Among women, CRC is the second most common cancer, accounting for 9.2% of cases, while in men, it holds the third spot at 10%. The incidence of CRC has increased by over 200,000 new cases annually from 1990 to 2012. Western nations report the highest rates, making up 55% of global CRC cases, though developing nations are beginning to experience a rise in cases due to rapid societal and healthcare developments. The use of EGFR inhibitors has also been linked to toxicity as one of the most prevalent adverse effects in CRC treatment. Genetic mutations in KRAS, NRAS, and BRAF are associated with the cancer's differentiation, spread, and invasiveness [1-4].

The global improvements in living standards and healthcare accessibility have led to substantial advancements in disease detection and treatment, positively impacting life expectancy worldwide [5, 6]. Despite these advancements, however, cancer-related deaths have risen by nearly 40% over the last 40 years. Projections suggest a 60% increase in cancer-related deaths within the next 15 years, with an estimated 13 million cancer deaths by 2030 [7-9].

Colorectal cancer rates vary significantly across different regions, with developed nations reporting higher incidences than developing countries. A lower socioeconomic status is a significant risk factor, particularly for rectal cancer, while the right colon is less affected. This disparity is likely due to lifestyle factors and limited access to medical care in certain regions. Early detection and improved treatment options have led to a 51% reduction in CRC mortality in the United States between 1975 and 2014. The National Cancer Institute reports a five-year survival rate of 65% for CRC patients [6-10].

Treatment for colorectal cancer has evolved to include laparoscopic surgery for primary tumors, removal of metastatic lesions, as well as neoadjuvant and palliative chemotherapy. Genetic mutations in specific genes, such as those involved in oncogenesis, tumor suppression, and DNA repair, play a key role in the development of CRC. Based on the mutation's origin, CRC can be classified as sporadic, hereditary, or familial [7-10].

This review explores the existing literature on the etiology, diagnosis, and treatment of colorectal cancer.

Materials and Methods

This systematic review adhered to established protocols for conducting comprehensive literature reviews.

Study design

A qualitative review was conducted in October 2022, focusing on existing research.

Study condition

The review examines current studies related to the causes, diagnosis, and treatment of colorectal cancer.

Search strategy

An extensive search was conducted across five prominent databases: PubMed, Science Direct, Web of Science, EBSCO, and the Cochrane Library to identify relevant studies. The search was limited to English-language publications and customized for each database. We used the following terms in PubMed: "colorectal cancer," "colon cancer," "causes," "aetiology," "diagnosis," "treatment," and "management," applying Boolean operators ("AND" and "OR") to combine keywords. Only full-text, free-access studies and human clinical trials were included in the results.

Selection criteria

Inclusion criteria

Studies were included based on their relevance to the research topic, focusing specifically on patients diagnosed with colorectal cancer. No age restrictions were applied.

Exclusion criteria

Publications that did not primarily address colorectal cancer, including duplicates and review articles not centered on the topic, were excluded.

Data extraction

Rayyan (QCRI) was used to identify duplicate results from the search. Titles and abstracts were reviewed for relevance according to inclusion and exclusion criteria. Full-text articles meeting the criteria were thoroughly reviewed. Discrepancies among reviewers were discussed to reach a consensus. A data extraction form was created to collect relevant details, including study title, authors, year of publication, study design, sample size, participant demographics, the likely causes of

colorectal cancer, diagnostic methods, treatment strategies, and key findings.

Risk of bias assessment

The quality of the studies was assessed using the ROBINS-I tool for non-randomized studies [11]. Any identified biases or limitations in the studies were reviewed and discussed.

Data synthesis strategy

The results of the review were summarized in tables, which provided an overview of the key data extracted from the studies. After completing the data extraction, decisions were made on how to best synthesize the information. Studies that met the full-text inclusion criteria but did not present clinical data on colorectal cancer patients were excluded from the final analysis.

Search results

A total of 779 studies were initially identified in the systematic search. After removing 85 duplicates, 682 studies were assessed by title and abstract, resulting in 390 exclusions. Despite searching 93 reports, 10 could not be retrieved. After a full-text review of 83 studies, 52 were excluded due to irrelevant outcomes. Ultimately, 7 studies were included in this systematic review.

Characteristics of the Included Studies

Table 1 displays the characteristics of the seven studies included in this review, which collectively involved 3,134,223 patients diagnosed with colorectal cancer. These studies were conducted in various countries, including Europe [11], the United States [9], Poland [12], Germany [13], India [14], and the Netherlands [15]. The research designs varied: 4 studies were cross-sectional [9, 11, 12, 16], 1 was prospective [13], 1 was a clinical trial [15], and 1 was retrospective [14]. The majority of cases were diagnosed using computed tomography (CT), with one study relying on surgical methods. Several studies also used MRI. CT was employed for determining CRC staging, specifically the TNM system (tumor, node, and metastasis).

Table 1. Overview of the key characteristics of the included studies

Study	Country	Study design	Participants	Age range	Outcome
Rawla *et al.* [12]	Europe	Cross-sectional	576,000 men and 521,000 women	0-74 years	The incidence shows a 1.51% lifetime risk of colon cancer for men and 1.12% for women. For rectal cancer, 430,000 men and 274,000 women will be diagnosed, with lifetime risks of 1.2% and 0.65%, respectively.
Lotfollahzad *et al.* [13]	United States	Cross-sectional	135,439 patients	< 50 years	Rectal cancer accounts for 30% of cases annually. Colorectal cancer collectively is the second leading cause of death among all cancer types.
Sawicki *et al.* [14]	Poland	Cross-sectional	1.9 million cases	< 90 years	Colorectal cancer is responsible for nearly 935,000 cancer-related deaths, with its mortality rate increasing to 11% of all cancer diagnoses.
Gökden *et al.* [15]	Germany	Prospective	47 patients	47-92 years	Symptoms like bright red rectal bleeding, unexplained anemia, abnormal bowel habits, or positive fecal occult blood tests led to hospitalization. Optical colonoscopy confirmed primary colorectal cancer, followed by surgery after PET/CT colonography staging.
Singla *et al.* [16]	India	Retrospective	31 patients	61-70 years	Disease prevalence was 38.7%. CT showed 83.3% sensitivity, 92% specificity, and a 71.4% positive predictive value.
Engelmann *et al.* [17]	Netherlands	Clinical practice	759 patients	N/A	CT's accuracy for TNM staging of colon cancer is moderate, but its main strength lies in detecting distant metastases accurately.
Reali *et al.* [18]	England	Cross-sectional	948 patients	32-69 years	Clinical and radiological staging often underestimated the tumor's TNM stage. CT with IV contrast was the key method for CRC staging.

Results and Discussion

Colorectal cancer ranks as the second and third most prevalent cancer in men and women, respectively. In 2012, 614,000 women (9.2% of all new cancer cases) and 746,000 men (10.0% of new cancer cases) were diagnosed with colorectal cancer globally [19].

The primary risk factor for colorectal cancer is age, with the likelihood of developing CRC increasing significantly after the age of 50 years. It is rare for colorectal cancer to develop before the age of 50 years, except in cases of hereditary cancers [20]. Apart from age, other inherent risk factors for colorectal cancer cannot be modified. For example, individuals with a history of colorectal cancer or those with ulcerative colitis have a 3.7% higher risk, while those with Crohn's disease face a 2.5% greater chance of developing colorectal cancer [21, 22].

Chronic inflammation caused by inflammatory bowel disease (IBD) often leads to dysplasia, an abnormal cell growth process. While dysplastic cells are not cancerous at the outset, they are more prone to transformation into anaplastic cells, which may eventually form tumors. A family history of colorectal cancer, especially when relatives are diagnosed before the age of 50 years, also increases the risk. Both genetic and environmental factors play a role in this familial risk [23].

Certain lifestyle factors can influence colorectal cancer risk, though these can often be reduced through changes in diet and physical activity. For instance, sedentary behavior is believed to raise the risk, but the exact relationship between inactivity and colorectal cancer remains unclear. On the other hand, regular physical activity enhances metabolism and gastrointestinal motility, which can improve metabolic health and reduce blood pressure over time [24].

Treatment for colorectal cancer can aim for either a cure or symptom relief. The approach depends on various factors, including the patient's overall health, preferences, and the stage of the cancer [25]. A multidisciplinary team is essential in determining whether a patient is a good candidate for surgery [26].

Early-stage colorectal cancer can often be treated with surgery for a potential cure. However, in cases where the cancer has advanced and metastasis is present, treatment generally focuses on palliation—relieving symptoms and maintaining patient comfort [27].

At early stages, colorectal cancer can be removed through a colonoscopy using techniques such as endoscopic mucosal resection or endoscopic submucosal dissection [28]. For a cure, patients with localized cancer require thorough surgical removal, ensuring clear margins. A partial colectomy is typically performed, which involves removing the affected portion of the colon or rectum, along with parts of the surrounding mesocolon and the blood supply, to also remove draining lymph nodes. Depending on the patient's condition and the specifics of the lesion, this can be done via open surgery or laparoscopically [27]. Afterward, the colon may be reconnected, or a colostomy may be necessary [28].

If there are limited metastases in the liver or lungs, surgical removal may be possible. Chemotherapy is sometimes administered before surgery to shrink the cancer and make it easier to remove. The liver and lungs are the most common sites for colorectal cancer recurrence [27]. In cases of peritoneal carcinomatosis, cytoreductive surgery combined with hyperthermic intraperitoneal chemotherapy (HIPEC) may be used to attempt eradication [29].

Conclusion

Colorectal cancer has emerged as one of the most prevalent cancers in recent decades, and its incidence is expected to rise further in the coming years. Despite significant advancements in treatment, mortality rates remain high, with 40-50% of patients succumbing to the disease. The development of colorectal cancer results from the interaction of environmental and genetic factors, leading to the formation of colon polyps that eventually progress to cancer, as outlined earlier. The progression from polyp to cancer is now understood to be a complex process primarily driven by genetic mutations and epigenetic alterations at the cellular level. A deeper understanding of these specific genetic changes is anticipated to pave the way for more precise and personalized treatment for individuals with polyps and cancers, informed by the molecular profiling of their colon tumors.

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