

CONTRIBUTIONS OF ENDOSCOPIC CAPSULE IN THE DIAGNOSIS AND MONITORING OF INFLAMMATORY BOWEL DISEASE

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Abstract: Objective: This review examines the role of capsule endoscopy in Inflammatory Bowel Disease (IBD), highlighting its significant contribution to early diagnosis and assessment of disease extent and activity. Method: We carried out a narrative bibliographic review in the PubMed - MEDLINE database, using an adapted PVO strategy. 64 articles were identified, of which 14 were selected following inclusion and exclusion criteria. Results: Capsule endoscopy (CE) plays a crucial role in the diagnosis, prognosis and monitoring of IBD, offering a detailed and non-invasive visualization of the gastrointestinal tract. Its evolution has transformed the diagnostic scenario, allowing a more accurate assessment of mucosal lesions. Furthermore, CE is essential for monitoring treatment response and evaluating mucosal healing. The potential of artificial intelligence in the analysis of endoscopic data stands out, representing a promising advance. Conclusion: CE is a valuable tool in the management of IBD, providing essential information for diagnosis, monitoring and treatment of the disease, and AI promises to further improve its clinical application.

Keywords: Capsule endoscopy, Inflammatory Bowel Disease (IBD), early diagnosis, monitoring, artificial intelligence.

INTRODUCTION

Crohn's disease (CD) is a chronic and heterogeneous inflammatory pathology of the gastrointestinal tract, commonly manifesting in the proximal portion, terminal ileum and colon. It is characterized by discontinuous lesions, interspersed with areas of healthy mucosa. This pathological profile has sparked increasing interest in the use of capsule endoscopy (CCE) for both diagnosis and patient management, aiming to assess the extent, severity and response to treatment (Saunders et al., 2024).

Capsule endoscopy is an orally ingested device that transmits images via telemetry. Initially developed as CCE-1 for colon cancer screening, the subsequent version, CCE-2, demonstrated superior sensitivity in detecting colon lesions compared to its predecessor, as well as offering a valuable alternative in cases of incomplete colonoscopy (Halder et al., 2022).

Despite its significant benefits, CCE-2 faces limitations such as the high volume of bowel preparation required and the high cost. However, it continues to gain popularity, especially in the treatment of patients with ulcerative colitis and other inflammatory bowel diseases, as it is a useful and minimally invasive tool (Hosoe; Hayashi; Ogata, 2020).

A notable aspect is the emerging role of CCE-2 in monitoring and treating patients with inflammatory bowel disease (IBD) during the pandemic, where it has proven to be a valuable tool (Halder et al., 2022). Furthermore, the method allows non-invasive observation of the severity of mucosal inflammation in patients with ulcerative colitis, minimizing discomfort for these individuals (Hosoe; Hayashi; Ogata, 2020).

Endoscopic healing is significantly associated with treatment time, showing better results with prolonged therapies and being able to reduce the risk of intestinal injuries. It is important to highlight that the use of anti-TNF- α therapies has been associated with a reduction in the need for intestinal surgeries, indicating that the evaluation of endoscopic healing in patients with Crohn's disease must not be restricted to the use of ileocolonoscopy alone (Esaki and Sakata, 2023).

This literature review aims to critically examine the role of capsule endoscopy in IBD, highlighting its significant contribution to early diagnosis, assessment of disease extent and activity, as well as monitoring response to treatment. The purpose is to synthesize

the latest evidence, identify emerging trends, and provide a solid foundation for improving the clinical use of capsule endoscopy in the effective management of IBD.

METHODOLOGY

This study consists of a narrative bibliographic review, organized based on the PVO strategy, adapted to address: Population or research problem (Inflammatory Bowel Disease - IBD), Intervention (capsule endoscopy), and Outcome (contributions to understanding, diagnosis and IBD monitoring). The guiding question defined was: "How has capsule endoscopy contributed to the understanding, diagnosis and monitoring of Inflammatory Bowel Disease, and what are the most recent advances that impact its clinical application, as evidenced by contemporary scientific literature?"

The searches were carried out in the PubMed - MEDLINE (Medical Literature Analysis and Retrieval System Online) database, using a combination of specific terms and Boolean operators: ("Capsule endoscopy" OR "Capsule enteroscopy") AND ("Inflammatory bowel disease" OR "IBD" OR "Crohn's disease" OR "Ulcerative colitis") AND ("Role" OR "Contribution" OR "Impact"). This strategy resulted in the initial identification of 64 articles.

The inclusion criteria applied were: articles in English, published between 2019 and 2024, that dealt with the topics of interest, including review-type studies, retrospective case studies and comparative analyses, all available in full. The exclusion criteria eliminated publications available only in abstract form and those that did not directly address the research question or that did not meet the other inclusion criteria.

After a careful analysis, based on the inclusion and exclusion criteria, 14 relevant articles were selected from the PubMed

database to compose the study collection. This methodological process enabled a comprehensive and updated review, allowing a detailed assessment of recent contributions and advances in the application of capsule endoscopy in the context of Inflammatory Bowel Disease, highlighting its importance for clinical practice in the diagnosis and monitoring of this condition.

DISCUSSION

CAPSULE ENDOSCOPY IN INFLAMMATORY BOWEL DISEASE

The CD is an inflammatory pathology that can affect any segment of the gastrointestinal tract and manifests itself at different tissue depths, which often represents a diagnostic challenge during procedures such as ileocolonoscopy. In this context, capsule endoscopy (CE) has emerged as an essential tool in the diagnostic, prognostic and monitoring management of patients with CD. Although ileocolonoscopy is often used as an initial investigation method, the use of CE is currently recommended for a more complete approach in the evaluation of these patients (Elosua et al., 2022).

Over the past two decades, the evolution of CE has significantly transformed the diagnostic landscape of inflammatory bowel diseases (IBD), offering a detailed and minimally invasive visualization of the gastrointestinal tract. Initially adopted with caution due to the risk of obstruction or retention in narrowed intestinal segments, CE is currently widely accepted and used for both diagnosis and monitoring of CD, allowing detailed evaluation of mucosal lesions that are often inaccessible to traditional endoscopic methods (Lahat; Veisman, 2021; Limpias Kamiya et al., 2022).

The colon capsule endoscopy (CCE), introduced in 2006, was initially seen as a

promising innovation in diagnosing intestinal diseases. However, unsatisfactory results with the first generation of capsules prompted the development of an improved version in 2009. Second-generation ECC represented a significant advance, increasing diagnostic accuracy, especially in patients with ulcerative colitis, a common type of IBD. ECC stands out for its non-invasive nature and requires only minimal preparation, allowing an effective assessment of the severity of mucosal inflammation in cases of ulcerative colitis. While the first generation showed inconsistent results, the second generation brought notable improvements in the detailed visualization of the intestinal mucosa (Lahat and Veisman, 2021).

As time passed and experience and data accumulated, the use of CE in the diagnosis and management of CD became increasingly prevalent. Currently, this technology is recognized in national and international guidelines as a primary tool for the diagnosis and continuous monitoring of CD treatment. Continuing technological advancement and the development of new capabilities, such as improvements in visualization, specific capsules for assessing intestinal permeability, colonic and enteropancreatic capsules, promise to further strengthen the role of CE in the diagnostic and therapeutic management of Crohn's disease (Lahat and Veisman, 2021).

The continuous monitoring of CD is essential for the effective management of this pathology, as it is a chronic inflammatory disease that can affect any part of the gastrointestinal tract, from the mouth to the anus. Although colonoscopy is considered the gold standard for mucosal evaluation, it is an invasive procedure that only allows visualization of the colon and part of the terminal ileum, leaving most of the small intestine inaccessible to direct inspection (Hosoe, Hayashi, Ogata, 2020).

Initially, when CE was introduced approximately two decades ago, there were concerns regarding its safety in patients with CD. However, with the accumulation of clinical experience and additional studies, CE has established itself as a safe and effective tool for diagnosing and monitoring CD (Lahat; Veisman, 2021). EC operates by ingesting a tiny capsule equipped with a camera, which captures detailed images of the inside of the digestive tract as it travels through the intestine. This method is non-invasive and associated with minimal side effects, making it one of the most accepted tools for diagnosing and monitoring CD (Hosoe, Hayashi, Ogata, 2020).

Recent guidelines, both American and European, highlight the importance of CE in the management of patients already diagnosed with CD, underlining its crucial role not only in the initial diagnosis, but also in the detection of post-surgical recurrences, in the evaluation of mucosal healing and response to treatment. This technology has been fundamental in guiding clinical decisions, facilitating the rational choice of treatments and the selection of medicines that offer real benefits to patients (Elósua et al., 2021).

A study involving the application of CE in patients with CD showed a significant improvement in results, with 75% of patients requiring treatment adjustments and showing statistical improvements in clinical and laboratory scores one year after the use of CE (Odeyinka et al., 2022).

Furthermore, studies demonstrate that CE is more specific in diagnosing small bowel injuries when compared to traditional modalities, directly impacting treatment options for patients of all ages and contributing to a substantial improvement in quality of life (Odeyinka et al., 2022). With the advancement of devices, the second generation of colon capsule endoscopy has significantly improved

the assessment of inflammation in patients with ulcerative colitis, another condition specific to IBD, offering a more accurate tool for this assessment (Hosoe; Hayashi; Ogata, 2020). Comparatively, CE outperforms other imaging modalities, such as magnetic resonance enterography (MRE) and computed tomography (CT), for its ability to detect subtle mucosal lesions, enabling early identification of CD and potentially improving clinical outcomes by allowing earlier and more precise interventions (Limpas Kamiya et al., 2022).

CE plays a crucial role in monitoring response to treatment and evaluating mucosal healing, fundamental aspects for the effective management of inflammatory bowel diseases (IBD). According to the consensus definition of the International Organization for the Study of Inflammatory Bowel Disease (IOIBD), mucosal healing is characterized by complete resolution of visible ulcers, which reinforces the importance of endoscopic evaluation in the management of Crohn's disease (Takenaka et al., 2020). In addition to its diagnostic role, EC has a significant influence on therapeutic decisions. A cohort study by Elosua et al. (2022) revealed that CE not only facilitates treatment escalation, but also allows precise medication adjustments, avoiding unnecessary therapies and guiding healthcare professionals to focus on more effective interventions, thus benefiting patients (Elosua et al., 2022).

In parallel, AI is emerging as a transformative force in several areas of medicine, including endoscopy, where its application to capsule endoscopy represents a promising advancement. AI contributes to the detection, characterization and classification of lesions in the gastrointestinal tract, expanding the applicability of CE. This technology promotes greater consistency in endoscopic data, making it more relevant to clinical practice by facilitating the diagnosis and classification of diseases. This

is particularly advantageous given human limitations, providing diagnostic assistance with low interpretative variability. However, it is essential to develop new algorithms and conduct studies that not only validate the effectiveness of AI in analyzing endoscopic data, but also explore its usefulness in histological and clinical contexts to improve the diagnosis and treatment of Crohn's disease (Solitano et al., 2022).

DYNAMIC MONITORING OF DISEASE ACTIVITY

CE has emerged as a promising non-invasive tool for dynamically monitoring the activity of Inflammatory Bowel Diseases (IBD). This method allows a reliable assessment of the healing of the small intestine mucosa in response to clinical treatment, being considered superior to CT enterography in CD, and can be used to monitor the postoperative period of patients undergoing surgical interventions (Levartovsky; Eliakim, 2023).

Pennazio et al. (2023) recommend that CD monitoring by CE be performed using activity scores, such as the Lewis score and the Capsule Endoscopy Crohn's Disease Activity Index (CEDCAI). These scores facilitate the assessment of the small intestine and the patient's response to current therapy.

In addition to monitoring disease activity, CE has been shown to be useful for predicting clinical and postoperative relapses, enabling the monitoring of exacerbations and anticipation of the future course of CD, which allows for early medical interventions (Levartovsky; Eliakim, 2023). In addition, Solitano et al. (2021) highlight the use of CE in monitoring quiescent patients with CD, capable of predicting disease exacerbations up to six months in advance.

The benefits of CE in clinical practice are directly reflected in the economic impacts

on health. Saunders, Torrejon Torres, and Konsinski (2019) concluded that the use of CE can reduce surgical costs and CD monitoring costs compared to conventional methods, in a five-year analysis carried out in the United States. Similar results were obtained by Saunders et al. (2024) in Italy, after a period of three years using CE to monitor patients with CD, showing a favorable financial impact when properly used.

Levartovsky and Eliakim (2023) state that EC is the best tool for diagnosing, monitoring the disease and modifying treatment, in addition to being able to anticipate relapses, enabling preventive interventions. Additionally, CE allows for the classification or reclassification of previously unspecified inflammatory diseases, offering new perspectives for treatment and a better understanding of disease progression (Singeap et al., 2023).

Singeap et al. (2023) emphasize that CE is considered first-line in the investigation of suspected diseases of the small intestine, providing essential information about the location of the lesions, which are prerequisites for subsequent enteroscopy, if necessary. Therefore, CE is a non-invasive method that allows diagnosing, monitoring, evaluating the course of the disease, reclassifying it and predicting recurrences, being a safe method. It allows the evaluation of segments of the gastrointestinal tract not visualized by upper digestive endoscopy and colonoscopy. With great potential to reduce costs, both in terms of diagnosis and the prevention of long-term complications, CE stands out as a valuable tool in the management of IBD.

FINAL CONSIDERATIONS

Capsule endoscopy is essential for diagnosing and monitoring IBD, offering a detailed, minimally invasive view of the gastrointestinal tract. Technological advances, such as second-generation capsules, have improved their diagnostic accuracy. CE has significant implications for clinical practice, enabling personalized interventions and reducing costs. The application of artificial

intelligence promises to expand its clinical utility. Its incorporation into IBD diagnosis and monitoring protocols is recommended. Investments in future research must explore new applications and technological improvements. CE represents a promising tool in the management of IBD, offering benefits in early diagnosis and monitoring of disease activity. Continued technological development can further improve the quality of life of IBD patients.

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