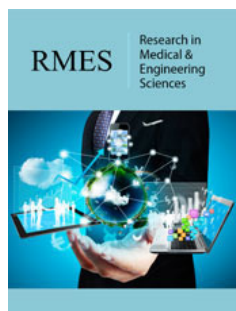


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Application of Artificial Intelligence in Imaging Examination of Acute Abdomen

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Abstract

Acute abdomen is a common and critical disease in clinic. Imaging examination is very important in its diagnosis, but traditional methods rely on experience and are inefficient. The development of AI (Artificial Intelligence) and deep learning provides a new idea for imaging diagnosis of acute abdomen, which can realize rapid identification and auxiliary diagnosis in appendicitis, digestive tract perforation, intestinal obstruction, pancreatitis and abdominal trauma, improve accuracy and efficiency, and reduce misdiagnosis and missed diagnosis. While challenges remain in data and clinical applications, AI shows promise in areas such as multimodal fusion and real-time decision support.

Keywords: Acute Abdomen; Medical Imaging; Artificial Intelligence; Deep Learning

Introduction

Acute abdomen is a comprehensive concept in clinical medicine, which refers to a group of diseases characterized by acute onset, rapid progression, and obvious abdominal symptoms and signs. The etiology of acute abdomen is complex and covers a wide range, but it can be divided into the following categories: inflammatory diseases; obstructive diseases; hemorrhagic diseases; traumatic acute abdomen. Acute abdomen is characterized by high incidence, rapid progression and high potential mortality [1,2]. Among diagnostic methods, medical imaging examination, as the most common auxiliary examination, can efficiently diagnose common acute abdomen. However, traditional medical image interpretation depends on doctors' experience and supervisors' differences. How to quickly and accurately complete image analysis in limited time has become one of the key challenges in the diagnosis and treatment of acute abdomen.

AI is a branch of computer science, an intelligent system that can simulate human thinking, identify complex situations, acquire learning abilities and knowledge, and solve problems. The introduction of artificial intelligence into image diagnosis of acute abdomen can effectively shorten the diagnosis time and improve the efficiency, reduce misdiagnosis and missed diagnosis, and objectively standardize the interpretation of images, thus improving the treatment effect of acute abdomen [3,4].

Current status of imaging diagnosis of acute abdomen

Acute abdomen is marked by severe abdominal pain necessitating swift and precise diagnosis for timely treatment [5]. Imaging is crucial in diagnosing this condition, with various techniques offering distinct advantages for lesion identification, disease evaluation, and clinical decision-making [6]. Despite its widespread use, imaging in acute abdomen diagnosis encounters several challenges and limitations.

Traditional X-ray examinations are advantageous due to their ease of use, quick imaging, and low cost, making them a common choice for preliminary assessments. They retain some utility in detecting free gas under the diaphragm, yet their sensitivity and specificity are limited, reducing their diagnostic value for most acute abdominal conditions [7]. Ultrasound, favored for its non-radiative nature and bedside accessibility, is routinely employed in diagnosing biliary tract diseases, appendicitis, and gynecological acute abdomen, particularly in populations like children and pregnant women. However, its diagnostic reliability is contingent on the operator's experience and can be compromised by factors such as body type and intestinal gas.

Currently, Computed Tomography (CT) is the preferred imaging technique for diagnosing acute abdomen due to its high spatial resolution, which vividly depicts abdominal organ structures and pathological changes. Numerous studies confirm CT's critical role in diagnosing appendicitis, intestinal obstruction, gastrointestinal perforation, and abdominal trauma. Enhanced CT further increases diagnostic accuracy. Nonetheless, CT poses challenges such as high radiation doses, large image data volumes, and the need for rapid, precise interpretation, thereby increasing the workload for radiologists in emergency situations [8].

MRI, known for its high soft tissue resolution, is invaluable in assessing complex conditions like pancreatic and gynecological diseases, as well as acute abdomen in pregnant women. Its non-radioactive nature makes it preferable for specific populations. However, its use in emergencies remains limited due to lengthy examination times, high costs, and limited equipment availability [9].

Current imaging techniques offer benefits for diagnosing acute abdomen but encounter challenges like limited diagnostic efficiency, operator dependency, and high interpretative demands in emergencies. Consequently, integrating emerging technologies, such as artificial intelligence, is increasingly vital for enhancing diagnostic efficiency and quality, paving the way for advancements in acute abdomen image diagnosis and treatment.

Application of artificial intelligence in imaging diagnosis of acute abdomen

AI in image diagnosis seeks to aid doctors by automating image analysis and lesion detection rapidly through deep learning and image processing technologies, enhancing diagnostic efficiency

and accuracy. This approach relies on extensive data training and machine learning algorithms to evaluate clinical patients, enabling intelligent machine-based diagnosis [10].

AI technology and image diagnosis research began in the 1960s, primarily relying on machine learning and statistical pattern recognition. In the 1980s, advancements in computer technology, algorithms, and statistics shifted AI from an intuitive, subjective approach to a quantitative, computational one, accelerating its development in medical imaging diagnosis [11]. Post-2012, the emergence of deep convolutional neural networks, coupled with large data sets and enhanced computing power via image processors, propelled deep learning research in medical imaging. This advancement significantly improved the accuracy of computer-aided diagnosis, marking the maturation of AI technology for clinical image diagnosis [12].

AI has been clinically integrated into medical imaging across various diseases, including tumour diagnosis, cardiovascular, neurological, and orthopaedic disorders. By leveraging automatic analysis, image recognition, and deep learning, AI enhances diagnostic accuracy and efficiency, reduces diagnostic errors, and offers robust decision support for clinicians [13]. In acute abdomen imaging, AI primarily functions through computer-aided diagnosis systems. These systems utilize image processing, computer vision, and medical image analysis to identify and label abnormal regions, aiding physicians in swiftly detecting lesions and improving both diagnostic accuracy and efficiency.

Acute appendicitis is a prevalent cause of acute abdominal pain. Traditional diagnosis depends on clinical judgment and imaging, yet early appendicitis can present vague imaging signs that are easily overlooked [14]. AI-enhanced ultrasound and CT scan autonomously detect appendicitis-related enlargement and local inflammation, thus enhancing diagnostic accuracy, particularly in complex cases, by assessing perforation or complicated inflammation, thereby informing treatment decisions [15]. Similarly, peptic ulcer perforation, another common acute abdomen condition, is typically identified by free gas on X-ray, though this method struggles with diagnosing other conditions [16]. AI-assisted CT analysis can automatically identify free gas and perforation sites, expediting rupture point detection in the digestive tract, improving diagnostic efficiency, reducing manual interpretation errors, and aiding in lesion localization and severity assessment [17].

Acute abdominal conditions such as intestinal obstruction, intestinal ischemia, acute pancreatitis, and abdominal trauma often require urgent attention and can be challenging to differentiate. AI technology can rapidly detect intestinal obstruction and assess blood flow abnormalities in intestinal ischemia through CT image analysis [18]. It evaluates acute pancreatitis severity based on CT indicators, aids in grading, and identifies complications [19]. Additionally, AI swiftly screens for organ damage in abdominal trauma, reducing the diagnostic time for multiple injuries.

Conclusion

Significant advancements have been achieved in applying artificial intelligence to imaging diagnostics for acute abdomen. AI demonstrates considerable potential in enhancing diagnostic efficiency, minimizing errors, and standardizing image interpretation. In emergency settings, AI rapidly processes extensive image data, aiding physicians in making more accurate decisions and alleviating their workload. As technology progresses, AI's role in the imaging diagnosis of acute abdomen is expected to expand further.

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