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Original Article

Non-Contrast and Low-Dose CT Applications in Abdominal and Emergency Imaging

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ABSTRACT

Computed tomography (CT) plays a pivotal role in abdominal and emergency radiology due to its rapid acquisition, high spatial resolution, and broad diagnostic capability. However, concerns regarding radiation exposure and contrast-related adverse effects have prompted increasing interest in non-contrast CT (NCCT) and low-dose CT techniques1. Recent advances in CT hardware, dose modulation strategies, and iterative reconstruction algorithms have enabled substantial radiation dose reduction without compromising diagnostic performance2. Accumulating clinical evidence suggests that NCCT can achieve high diagnostic accuracy in a variety of acute abdominal conditions, particularly in emergency settings where timely diagnosis is critical3. NCCT has proven especially effective in the evaluation of urolithiasis, acute appendicitis, bowel obstruction, gastrointestinal perforation, intra-abdominal hemorrhage, and select inflammatory conditions1. In addition, low-dose CT protocols have demonstrated promising results in the detection and follow-up of abdominal malignancies, offering a safer alternative for patients requiring repeated imaging. Beyond acute pathology, NCCT and low-dose CT frequently reveal incidental findings, which may influence further diagnostic workup and long-term patient management.4 The ability to obtain clinically meaningful information while minimizing radiation exposure is particularly relevant for young patients, pregnant individuals, and those with chronic or recurrent abdominal complaints. This review synthesizes current clinical evidence on the diagnostic accuracy and clinical utility of NCCT and low-dose CT across a wide spectrum of abdominal diseases and incidental findings5. We further examine their impact on clinical decision-making, treatment planning, and patient outcomes, emphasizing their growing role as efficient, safe, and cost-effective imaging tools in modern abdominal and emergency radiology practice.

Keywords: Non-contrast CT, Low-dose CT, Ultra-low-dose CT, Acute appendicitis, Renal colic, Abdominal malignancy, Emergency imaging

INTRODUCTION

Computed tomography (CT) has fundamentally transformed abdominal and emergency radiology by enabling rapid, noninvasive, and highly accurate diagnosis across a wide spectrum of pathologies[1]. Contrast-enhanced CT (CECT) continues to serve as the reference standard for many abdominal indications. However, increasing awareness of radiation exposure, potential contrast-related adverse effects, and rising healthcare costs has driven growing interest in non-contrast CT (NCCT) and dose-reduction strategies. Recent advances in CT scanner technology, automated dose modulation, and iterative image reconstruction techniques have facilitated the widespread adoption of low-dose and ultra-low-dose CT protocols with minimal loss of diagnostic accuracy[6]. Within this context, NCCT has emerged as a practical and efficient imaging tool, particularly in emergency settings where rapid decision-making is essential[2]. This review summarizes key clinical studies evaluating the role of NCCT and low-dose CT in the assessment of acute abdominal conditions and the detection of abdominal malignancies.

2. Low-Dose NCCT in Acute Appendicitis

The role of low-dose NCCT in the evaluation of suspected acute appendicitis has been well explored. Roshan Singh et al. assessed the diagnostic efficacy of low-dose NCCT in adults presenting with right lower quadrant pain, incorporating body mass index (BMI)–based considerations[3]. In this prospective study of 83 patients who underwent both standard- and low-dose NCCT, two radiologists independently and blindly interpreted the images. The appendix was

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adequately visualized in 96.4% of low-dose examinations, demonstrating image quality comparable to that of standard-dose scans[4]. Diagnostic performance was excellent, with a sensitivity of 98.2% and a specificity of 100%[7]. In addition to identifying appendicitis, low-dose NCCT detected alternative diagnoses in 22 patients, underscoring its broader diagnostic value[8]. Importantly, radiation exposure was reduced by approximately 88%, supporting the use of low-dose NCCT as a reliable, rapid, and cost-effective first-line imaging modality for suspected acute appendicitis[3].

3. NCCT for Renal Colic and Urolithiasis in Emergency Settings

NCCT has become the imaging modality of choice for patients presenting with suspected renal colic in emergency departments[9]. Cullen et al., in a single-institution retrospective audit of 500 NCCT examinations, reported the detection of renal or ureteric calculi in 56% of patients. Beyond stone detection, NCCT revealed unexpected intra-abdominal pathology in 19% of cases, with clinically significant alternative diagnoses identified in 13%, including gastrointestinal disease, malignancy, and vascular emergencies. These findings highlight the comprehensive diagnostic capability of NCCT and its critical role in guiding appropriate patient management[10]. Further reinforcing the utility of NCCT, Abramson et al. demonstrated that stone attenuation values measurd in Hounsfield Units (HU) on NCCT are strong predictors of extracorporeal shock wave lithotripsy (ESWL) outcomes. In their cohort of 96 patients, stones with densities ≤750 HU were associated with higher clearance rates, fewer ESWL sessions, and a six-fold greater likelihood of complete stone clearance. This emphasise the role of NCCT not only in diagnosis but also in treatment planning and prognostication[11]. Kravchick et al. evaluated the combined use of NCCT and dynamic renal scintigraphy (DRS) in patients with refractory renal colic. Their study demonstrated that the combined approach achieved the highest diagnostic sensitivity (96%), with DRS contributing improved specificity and predictive value. NCCT was particularly valuable in assessing stone size, location, and the degree of anatomical obstruction, reinforcing its importance in emergency urological decision-making[12].

4. Ultra-Low-Dose CT in Acute Abdominal Pathology

Efforts to further reduce radiation exposure have led to the development of ultra-low-dose CT (ULDCT) protocols. Gavrielli et al. investigated the clinical utility of ULDCT for detecting acute abdominal pathology in emergency room settings. In a retrospective cohort of 325 patients, ULDCT demonstrated a clinical concordance rate of 66.4% and identified pathology in 41.2% of cases[6]. Notably, radiation exposure with ULDCT was comparable to that of plain abdominal radiography, while offering a substantially higher diagnostic yield[5]. Positive ULDCT findings were associated with increased rates of hospitalization and surgical intervention, highlighting its clinical relevance and potential role as a superior alternative to conventional radiography in the initial assessment of acute abdominal pain[10].

5. NCCT in Abdominal Cancer Screening and Detection

Beyond emergency care, NCCT has shown increasing promise in the detection and screening of abdominal malignancies. The Yorkshire Kidney Screening Trial (YKST), conducted by Collins et al., evaluated the feasibility of incorporating abdominal NCCT into community-based lung cancer screening programs. Among 4,019 participants, clinically significant findings were identified in 5.3% of individuals. Kidney cancer was detected in 0.25%, while other renal tumors and complex cysts were identified in 0.62% of participants. High patient acceptance and minimal additional scanning time support the feasibility of integrated NCCT screening approaches for early detection of abdominal malignancies[2]. Parida et al. assessed the role of CT in the evaluation of gastric neoplasms with histopathological correlation. In their prospective study of 60 patients, CT accurately characterized tumor location, patterns of wall thickening, regional lymphadenopathy, adjacent organ invasion, and distant metastases. These findings underscore the critical role of CT in staging and treatment planning for gastric cancer. Similarly, Pandey et al. highlighted the importance of CT imaging—particularly contrast-enhanced protocols—in detecting abdominal malignancies, differentiating benign from malignant lesions, and assessing disease extent. The high sensitivity and

specificity of CT provide essential information for early diagnosis, therapeutic decision-making, and follow-up, ultimately contributing to improved patient outcomes[6].

6. Clinical Impact and Future Perspectives

Collectively, available evidence demonstrates that NCCT and low- to ultra-low-dose CT protocols offer substantial diagnostic value across a wide range of abdominal and emergency conditions. These techniques enhance diagnostic confidence, enable detection of alternative or incidental pathology, inform therapeutic strategies, and significantly reduce radiation exposure. Ongoing advances in detector technology, iterative reconstruction, and artificial intelligence–assisted image analysis are expected to further improve image quality at lower radiation doses, thereby expanding the clinical applicability of NCCT and low-dose CT in routine abdominal and emergency radiology practice[13].

CONCLUSION

Non-contrast and low-dose CT have firmly established their role as essential imaging tools in abdominal and emergency radiology. A growing body of evidence consistently demonstrates that these techniques provide high diagnostic accuracy while maintaining an excellent safety profile, particularly in common and time-sensitive conditions such as acute appendicitis, renal colic, and selected abdominal malignancies. Their ability to deliver reliable diagnostic information without the routine use of intravenous contrast or higher radiation doses makes them especially valuable in emergency settings and in patients requiring repeated imaging. By effectively balancing diagnostic performance with radiation safety, NCCT and ultra-low-dose CT reflect a meaningful shift toward more patient-centered and resource-conscious imaging practices. Advances in scanner technology, image reconstruction, and dose optimization have further expanded their clinical applicability, enabling confident diagnosis even at substantially reduced radiation levels. As experience with these techniques continues to grow, NCCT and low-dose CT are likely to play an increasingly important role not only in emergency care but also in surveillance and population-based screening strategies, contributing to improved clinical decision-making and patient outcomes.

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