



CT IMAGING IN THE ELDERLY: ADDRESSING CHALLENGES AND ENHANCING DIAGNOSTIC ACCURACY

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Abstract

The increasing proportion of elderly individuals globally presents challenges in healthcare. Computed tomography (CT) is a widely utilized radiological modality valued for its rapid acquisition capabilities and accessibility. CT interpretation in elderly patients might be complicated due to age-related physiological changes: decreased bone density, organ elasticity, and increased calcifications. These factors, along with comorbidities like cardiovascular disease, diabetes, and cognitive impairments, complicate CT interpretation. Elderly people are at increased risk of contrast-induced nephropathy due to reduced renal function. Metal fragments, such as pacemakers, coronary stents and stent-grafts, are additional artefacts during CT. Moreover, patient cooperation can be limited by conditions such as dementia or hearing loss, leading to issues with motion and positioning during scans.

Considering age-related changes and comorbidities, the solutions in CT scanning might be personalized and specific to the elderly CT protocols. Pre-CT preparation, including clear instructions and strategies for patients with cognitive impairments or physical limitations, is beneficial. Multidisciplinary collaboration among radiologists, geriatricians, and specialists enhances diagnostic accuracy and cooperation. Technological advancements reduce artefacts, enhance image quality, and lower radiation exposure. Educating medical staff on the needs of elderly patients ensures better comfort and care. Implementing complex solutions for optimizing CT imaging might improve the diagnostic outcomes and patient experience.

Keywords: aged; cardiovascular diseases; multimorbidity; geriatricians; tomography, X-Ray computed; patient care; aging

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Key Messages for Research and Practice

- Age-related physiological and anatomical changes, comorbidity, and metal devices in elderly patients pose significant challenges for CT imaging.
- A multidisciplinary approach and individualized CT protocols essential for optimal care. Your expertise and collaboration are crucial in this process.
- The complex strategy, including individualized CT protocols, a multidisciplinary approach, patient preparation and support, technological advancements, and education and training, can enhance imaging outcomes and improve patient care.

Introduction

The global population is undergoing a demographic shift, with an increasing proportion of elderly people in the healthcare system [1]. The prevalence of multimorbidity in elderly patients needs advanced diagnostic tools for complex and comprehensive management. Computed tomography (CT) is a widely utilized radiological modality valued for its rapid acquisition capabilities and accessibility [2]. CT imaging is particularly indispensable in urgent settings, as it can provide rapid diagnoses and scan the entire body. It is essential in cases involving combined pathologies common in elderly patients.

However, the application of CT in geriatric populations presents distinct challenges. Age-related physiological changes [3], limitations in patient cooperation [4], and the coexistence of multiple comorbid conditions complicate the diagnostic process. Radiologists must understand the specific circumstances when performing CT imaging on elderly patients. Moreover, other healthcare professionals, including family physicians, general practitioners, and palliative care specialists, should be appropriately trained and prepared to support elderly patients through the CT procedure. This comprehensive approach is essential to optimizing diagnostic accuracy and enhancing patient care for the elderly.

This opinion paper aims to highlight the most prevalent challenges while performing CT on the elderly, including technical, interpretive, and clinical complexities, and provide solutions to improve diagnostic accuracy and optimize patient care.

Search methodology

PubMed/MEDLINE database was searched through. The search included keywords: “computed tomography” or “CT”, “elderly” or “older adults”, “challenges”. Extracted articles in English, species – humans, with the publication date – 5 years, aged: 65+ years. Case reports, study protocols, interviews, historical article, books and clinical conferences were excluded. The search methodology was in coherence with the recommendations for narrative reviews [5]. Large Language Model was used for improving academic English.

Challenges

Age-related anatomical and physiological changes. The human body changes with age, which impacts anatomy and physiology [6].

The main issues impacting image interpretation are bone density [7] and tissue elasticity [8].

- Calcifications, sarcopenia, kyphosis, and reduced organ density can obscure CT findings [9,10].
- Extensive atherosclerosis with age may lead to calcifications, which obscure imaging or mimic pathology [11]. This is especially important for patients with ischemic heart disease [12,13], where CT coronary angiography might be uninformative and require additional investigation [14–18]. Atherosclerosis of the lower extremities is common in elderly patients, leading to ischemia and ulceration [19].
- Decreasing elasticity (reduced vascular compliance) might result in higher vascular complications, such as acute aortic syndrome [20–23].
- Fat infiltration – issues with image interpretation [24–26].
- Deaf – the patient is unable to hear commands due to hearing loss [27].

The ageing changes resulted in the following challenges during CT – technical issues.

Motion and Artifact Management. Ageing cardiovascular and respiratory system changes, including heart rate, blood pressure, and pulmonary function, can complicate CT imaging.

- Breath (dyspnea). Patients are unable to hold their breath during the CT scan.
- Cognitive impairments may limit patient cooperation [28].
- Tremors [29–31].
- Limited joint mobility. Unable to raise arms and hold them above the head [32–34]

Comorbidities and Multimorbidity. The coexistence of cardiac, pulmonary, and oncological diseases makes interpretation complex [35]. Moreover, differentiating acute from chronic findings is particularly challenging [32]. The most typical comorbidities are diabetes, hypertension, cardiovascular disease, and neurodegenerative disorders.

- Overlapping symptoms. Multimorbid patients often present with overlapping symptoms. The primary diagnosis might be found later after describing all anatomical changes we detect.
- Obesity impacts image quality and technical issues (like voltage and, as a result, radiation exposure) [36].
- Chronic kidney disease. Older adults are at increased risk of contrast-induced nephropathy (CIN) due to reduced renal function [37–39].

Use of contrast media. CT with contrast enhancement should be properly described, including which contrast media and in what amount.

Metal fragments. Implanted pacemakers, stents, or other medical implants have artefacts on CT images [40–42].

Patient Cooperation and Comfort. Elderly patients might be with cognitive impairments such as dementia or Alzheimer's disease [43–45]. They may struggle to follow instructions during the CT scan. Fear or anxiety are widespread.

Solutions

Individualized CT protocols. Develop and apply age-specific CT protocols based on the anatomical-physiological changes. Adopting protocols for patient-specific factors, such as main goal, renal function, and clinical urgency, ensures high-quality imaging [46]. Moreover, adaptations of the CT protocol refer to the comorbidities. E.g. body CT in multimorbidity patients. CT protocols should include adjustments for radiation dose, contrast media, body position, voice instructions and scan timing.

Multidisciplinary Approach. Geriatricians, family physicians, and other healthcare providers should work closely with radiologists [47]. For example, close communication with cardiologists, neurologists, and oncologists enhances diagnostic interpretation and treatment planning [48,49]. Medical staff should understand the clinical context of elderly patients, providing appropriate clinical information for radiologists. On the other hand, radiologists should collect anamnesis to propose the best CT protocol. The aim is to perform high-quality and informative CT scans with adequate timing, radiation exposure, contrast, and patient comfort.

Patient Preparation and Support. Patient comfort is essential, but the clinical question should be answered after the procedure. Elderly patients should be prepared for the CT scans and provided with clear instructions. Transitioning to shallow breathing (frequent, light respiratory movements with minimal chest motion) can also help in cases where holding one's breath is impossible. Patients who cannot hear commands due to hearing loss should be trained to follow the CT scanner's light indicators. Scanning can be performed with arms down if patients cannot raise their arms and hold them above their heads. Sedation might be proposed when appropriate.

Technological Advancements. Strategies to reduce breathing artefacts include a higher pitch and caudo-cranial direction of the scan [50]. Besides that, older adults are less sensitive to radiation-induced malignancies, so dose optimization remains a priority [51,52]. Dual-energy CT and iterative reconstruction improve diagnostic accuracy while reducing artefacts and dose [53,54]. Techniques like CT perfusion for stroke or dynamic imaging for tumour perfusion provide physiological insights

beyond anatomical visualization [55]. Artificial intelligence (AI) tools assist in artefact reduction, motion correction, and automated detection of subtle findings. Photon-counting CT promises higher resolution and contrast efficiency in elderly patients [56–58].

Education and Training. Medical staff should be trained to work with elderly patients to better understand their problems and needs. The primary advice might be gentle guidance during the CT procedure, particularly for those who have difficulty hearing, repeating, or following instructions.

In conclusion, as the global elderly population increases, the prevalence of multimorbidity poses significant challenges in diagnostic imaging. Computed tomography (CT) plays a critical role in diagnosing complex conditions in older adults, but age-related physiological changes, comorbidities, and limitations in patient cooperation complicate the process. Tailoring CT protocols to the specific needs of elderly patients, adopting a multidisciplinary approach, and utilizing advanced technologies can improve diagnostic accuracy and patient comfort. Preparing patients for procedures and enhancing staff training are essential for ensuring optimal care. Ongoing advancements in imaging techniques and education will be vital to providing high-quality care for this growing population.

AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST

The author has completed the ICMJE Disclosure Form and declares no potential conflicts of interest.

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ETHICS APPROVAL

Not applicable

DISCLAIMER

No part of this article is copied or published elsewhere in whole or in part.

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