Innovative Imaging

Artificial Intelligence–Enhanced 3D Reconstruction of Parapneumonic Effusion in a Pediatric Patient: A Novel Visualization Approach

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1. Innovative Imaging

We present a case of a 3-year-old male who was admitted to the pediatric intensive care unit (PICU) with severe left-sided pneumonia and a large parapneumonic pleural effusion. The patient initially presented with epigastric abdominal pain and intermittent symptoms over the course of one week, eventually leading to progressive respiratory compromise and hypoxemia, with oxygen saturation levels declining to 90–92% on room air and evidence of intercostal retractions. Chest radiography demonstrated retrocardiac airspace consolidation, and a subsequent chest computed tomography (CT) confirmed multifocal left-sided airspace opacities with a significant associated pleural effusion. No evidence of loculation was found.

What sets this case apart is the integration of advanced post-processing imaging techniques to enhance visualization and understanding of the extent of pulmonary pathology. Using Lung CT Segmenter in 3D Slicer v5.8.1 [1], we performed an automated parenchymal segmentation to isolate and quantify affected lung regions. This was followed by a 3D reconstruction using Lung CT Analyzer [2], leveraging an artificial intelligence module that rendered a volumetric model of the pulmonary structures and pleural effusion (**Figure**).

These imaging innovations provided a comprehensive spatial understanding of the pneumonia's severity and distribution, facilitating multidisciplinary clinical decision-making. The AI-assisted 3D reconstruction helped delineate the extent of parenchymal involvement and confirmed the absence of loculated collections. While the patient was managed conservatively without invasive drainage, the advanced visualization supported close monitoring and contributed to the therapeutic strategy. The patient received intravenous therapy for 21 days during hospitalization, followed by an additional 7 days as an outpatient, completing a total of 28 days of treatment. Follow-up chest radiography at 30 days demonstrated complete resolution of the parapneumonic effusion, accompanied by clinical improvement.

By incorporating 3D AI-generated models into standard CT interpretation, we highlight the potential of emerging tools in improving pediatric respiratory diagnostics. This case illustrates how innovative imaging workflows can enhance diagnostic precision and communication in complex pediatric infections, especially when managing evolving conditions like parapneumonic effusions where early, informed decisions are critical [3,4]. In medical image interpretation, AI systems can refine diagnostic accuracy by highlighting subtle findings that might otherwise be overlooked [5]. AI-based 3D imaging may serve as a useful aid in evaluating disease severity, planning interventions, and educating future clinicians.

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2. Statements & Declarations

Image originality: The submitted images have not been previously published nor are they undergoing review for publication elsewhere.

3. Figure

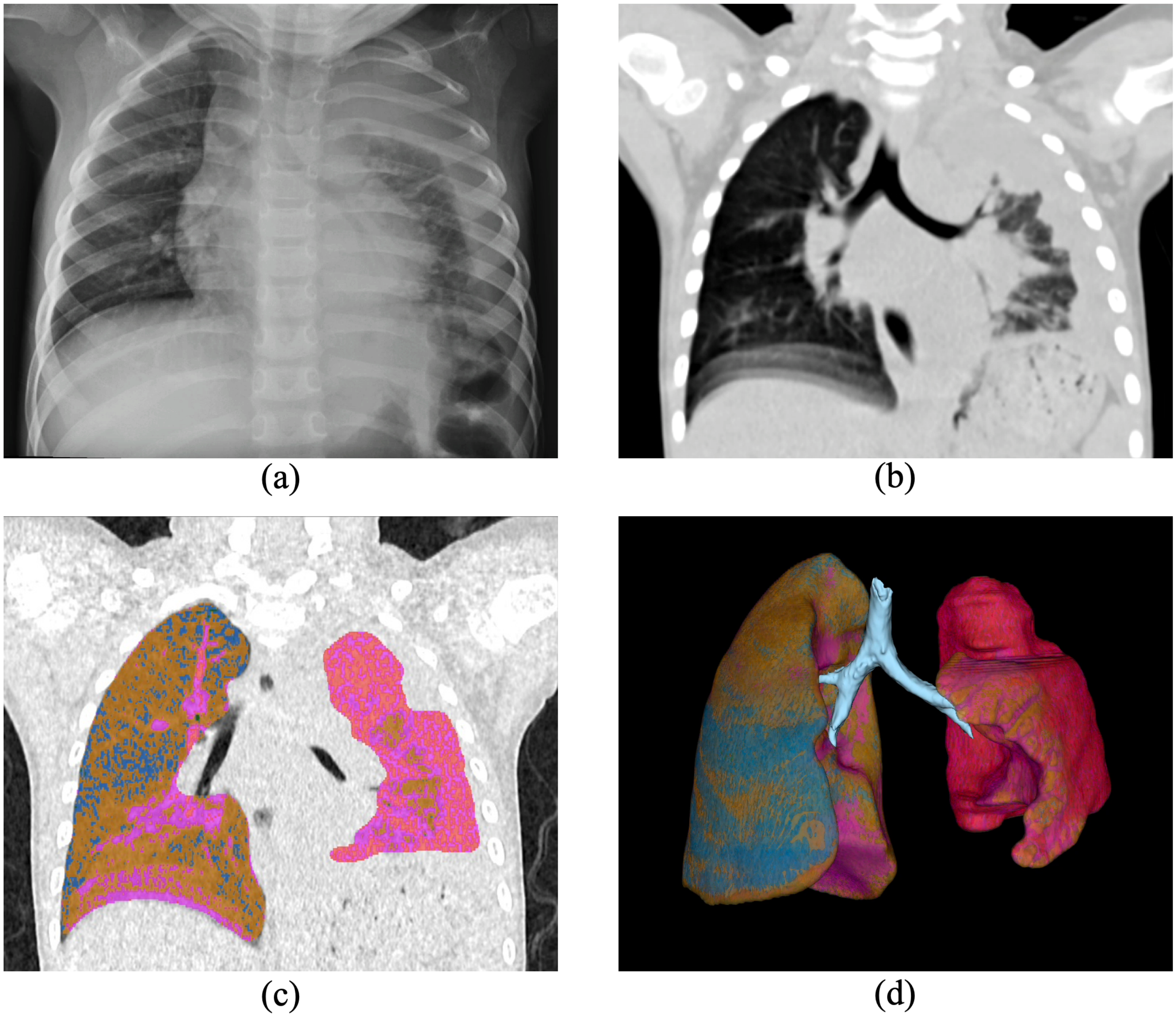

Figure. Multimodal imaging evaluation and AI-enhanced 3D reconstruction in a pediatric patient with pneumonia and parapneumonic effusion. (a) Chest radiograph showing retrocardiac airspace consolidation, concerning for left lower lobe pneumonia. (b) Coronal CT view of the thorax demonstrating multifocal left-sided airspace opacities with associated large parapneumonic pleural effusion. (c) Lung parenchyma segmentation using Lung CT Segmenter module in 3D Slicer (v5.8.1), highlighting affected lung zones. (d) AI-assisted 3D lung reconstruction using Lung CT Analyzer, showing volumetric distribution of aerated versus consolidated lung regions and pleural effusion. Light blue denotes the airway; dark blue represents normally aerated parenchyma; orange indicates areas of infiltration or inflammation; and pink represents regions of lung collapse.

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Conflicts of Interest: The authors declare no conflicts of interest.

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