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Cardiothoracic Ratio and Aortic Knob Diameter in Immunocompromised Patients with Pulmonary Infections

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Abstract **Review Article**

Pulmonary infections in immunocompromised patients (ICPs) are a major cause of morbidity and mortality, often accompanied by cardiovascular changes. This study assessed the association between pulmonary infections and cardiovascular response, using cardiothoracic ratio (CTR) and aortic knob diameter (AKD) as indicators, in ICPs. A retrospective cross-sectional analysis was conducted on 105 posterior–anterior chest radiographs from ICPs with confirmed pulmonary infections. Transverse cardiac diameter (TCD), transverse thoracic diameter (TTD), CTR, and AKD were measured using standard radiographic techniques. Descriptive statistics, independent t tests, and regression analyses were performed. Mean TCD and TTD were 17.05 ± 2.50 cm and 34.06 ± 4.60 cm, respectively, with a mean CTR of 0.500 ± 0.05. Mean AKD was 4.58 ± 0.66 cm. CTR was significantly higher in ICPs compared to immunocompetent controls ($p = .007$), and AKD was also significantly elevated ($p = .05$). Regression analysis demonstrated a strong positive relationship between CTR, AKD, and age ($R^2 = .659$, $p < .001$). These findings suggest that pulmonary infections in ICPs are associated with measurable increases in cardiac size and aortic knob diameter. Routine chest radiography can therefore serve as a valuable, low-cost tool for early detection of cardiovascular changes in this vulnerable population, potentially guiding timely intervention and improving outcomes. Further research with larger cohorts and longitudinal follow-up is recommended to confirm causality and refine screening protocols.

Keywords: aortic knob diameter, cardiothoracic ratio, chest radiography, immunocompromised patients, pulmonary infection.

HIGHLIGHTS

- Pulmonary infections in immunocompromised patients are linked to significant increases in cardiothoracic ratio (CTR) and aortic knob diameter (AKD).

- Mean CTR and AKD were significantly higher in immunocompromised patients than in immunocompetent controls ($p < .05$).

- A strong positive correlation exists between CTR, AKD, and patient age ($R^2 = .659$, $p < .001$).

- Chest radiography provides a cost-effective method for early cardiovascular risk detection in this patient group.

- Findings support routine cardiovascular monitoring in immunocompromised patients with pulmonary infections.

INTRODUCTION

Pulmonary infections are a leading cause of morbidity and mortality worldwide, particularly among immunocompromised patients (ICPs). This population—comprising individuals with HIV/AIDS, those undergoing chemotherapy, post-transplant recipients, and patients on long-term immunosuppressive therapy—faces increased susceptibility to opportunistic and severe respiratory infections due to impaired host defenses (World Health Organization, 2023). In addition to respiratory compromise, pulmonary infections in ICPs may precipitate significant cardiovascular changes, including alterations in cardiac size and vascular structures detectable on chest radiographs.

The cardiothoracic ratio (CTR), calculated from the transverse cardiac and thoracic diameters, serves as a simple radiographic

index of cardiac size. An enlarged CTR has been linked to a range of cardiovascular pathologies, including cardiomegaly and heart failure (Danias et al., 2020). Similarly, the aortic knob diameter (AKD)—representing the radiographic width of the aortic arch—may enlarge in response to chronic hemodynamic stress or vascular pathology (Kim et al., 2019). Despite their clinical value, few studies have examined CTR and AKD in the context of pulmonary infections among ICPs, particularly in sub-Saharan Africa, where both infectious diseases and cardiovascular conditions are prevalent.

Early recognition of radiographic indicators of cardiovascular compromise in ICPs may allow for prompt intervention, potentially improving patient outcomes. This study aimed to evaluate the association between pulmonary infections and cardiovascular response, as measured by CTR and AKD, in immunocompromised patients.

METHOD

Study Design and Setting

This retrospective cross-sectional study was conducted at the Radiology Department of the Federal Medical Centre, Keffi, and Nasarawa State, Nigeria. The department provides diagnostic imaging services to a diverse patient population from both urban and rural communities in central Nigeria.

Study Population

The study included 105 immunocompromised patients (ICPs) with confirmed pulmonary infections who underwent standard posterior–anterior (PA) chest radiography between January and December 2024. Immunocompromised status was defined as the presence of HIV/AIDS, ongoing chemotherapy, post-organ transplantation, or long-term corticosteroid/immunosuppressive therapy. A control group of 105 age- and sex-matched immunocompetent patients with normal chest radiographs was used for comparative analysis.

Inclusion and Exclusion Criteria

Inclusion criteria for ICPs were: Age ≥ 18 years, confirmed diagnosis of pulmonary infection based on clinical and laboratory findings, and availability of high-quality PA chest radiograph.

Exclusion criteria were: severe chest wall deformities affecting measurement accuracy, previous thoracic surgery altering normal anatomy, and incomplete clinical records.

Radiographic Measurements

All radiographs were acquired using a calibrated digital radiography system. Measurements were performed manually on PACS workstations using electronic calipers: Transverse Cardiac Diameter (TCD), Transverse Thoracic Diameter (TTD), Cardiothoracic Ratio (CTR), and Aortic Knob Diameter (AKD).

DATA ANALYSIS

Data were analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics summarized continuous variables (mean ± SD) and categorical variables (frequency, percentage). Independent-samples t tests compared means between ICPs and controls. Pearson correlation coefficients assessed relationships between CTR, AKD, and age. Multiple linear regression models determined predictors of CTR and AKD. A significance level of $p < .05$ was adopted.

Ethics Approval and Consent

Ethical approval was obtained from the Health and Research Ethics Committee of the Federal Medical Centre, Keffi. Written consent for the use of clinical data and radiographs was obtained from participants, and institutional permission was granted by the Specialist Hospital, Lafia, and Nasarawa State, Nigeria.

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