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ORIGINAL ARTICLE

High prevalence of abnormalities on chest radiography in rheumatoid arthritis

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Abstract

Introduction Chest radiography (CXR) is commonly performed in rheumatoid arthritis (RA), particularly for the diagnosis of pulmonary disease. However, other structures are visible on CXR, abnormalities of which may contribute to morbidity and early mortality. This study was undertaken to evaluate the extent of CXR abnormalities in RA patients.

Methods Consecutive out-patients meeting the 2010 ACR/EULAR classification criteria for RA were included. The most recent CXR was assessed by two independent reviewers. Abnormalities identified were recorded and compared to the formal CXR report. Predictors of abnormalities on CXR were assessed using chi-squared tests. SPSS 18.0 was used for statistical analysis.

Results One hundred and ninety-eight patients were included. Mean age was 62 years (range 18–90). One hundred and nine (55.1%) were current or ex-smokers. One hundred and fifty-six (79%) patients were seropositive and 123 (62.1%) had joint erosions. A recent CXR was available in 163 (82%) cases. Abnormalities were identified in 129 (79.1%). Ninety-seven (60%) had bony abnormalities. Seventy-one (43.6%) had pulmonary abnormalities; old tuberculosis in 34 (20.9%), hyperinflation in 24 (14.7%), interstitial changes in 20 (13.3%), nodules in 4 (2.4%), consolidation in 2 (1.2%), and pneumothorax in 1 (0.6%). Cardiomegaly was identified in 37 (22.7%) and aortic calcification in 24 (14.7%). Age ($p = 0.001$), male gender ($p = 0.01$), and seropositivity ($p = 0.04$) were significantly associated with lung abnormalities. Cardiomegaly was associated with hypertension ($p = 0.012$) and ischaemic heart disease ($p = 0.018$).

Conclusion Abnormalities were identified in 79% of chest radiographs in RA patients. Sixty-six percent of these were not reported. Clinicians need to be aware of the need to check for abnormalities.

Key Points
- *RA patients have a high prevalence of CXR abnormalities.*
- *Many of these are of clinical significance.*
- *Age, being male, and seropositivity were associated with lung abnormalities.*

Keywords Chest · Radiography · Rheumatoid arthritis

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease affecting 1% of the population in the developed world [1]. While joint symptoms are often a predominant early feature, RA is a true systemic disease involving multiple organs and tissues with the potential to impact on morbidity and mortality [2, 3]. Optimal treatment of RA, including the identification and treatment of disease-related complications, significantly reduces these risks [4, 5].

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Chest radiography (CXR) is a routine investigation in patients with RA, and is frequently performed either at disease onset, prior to biologic treatment, or in the presence of pulmonary symptoms [6–8]. Several complications of systemic RA disease and/or treatment may be visible on CXR including abnormalities of the lungs, heart, aorta, hila, bones, and joints. Formal CXR reports usually focus on acute pulmonary findings, and tend not to mention other potentially relevant findings [9]. However, CXR provides a valuable opportunity to detect pathology at an early stage and allow early therapeutic intervention if needed [10, 11]. This study was undertaken to evaluate the extent of abnormalities on CXR of patients with RA, and the frequency with which these were formally reported. It was not our aim in this study to evaluate the prevalence of radiographic abnormalities in early RA, rather it was to assess how often abnormalities are present and reported in RA patients at any stage of the disease process.

Methods

Patients

Consecutive patients with a confirmed diagnosis of RA attending the out-patient rheumatology department of St. James's Hospital, a large academic teaching hospital with secondary and tertiary care functions, were included in the study. All patients met the 2010 ACR/EULAR classification criteria for RA [12].

Data collection

Demographic and clinical details were collected on all patients. Disease duration, current medications, and seropositivity for rheumatoid factor (RF) or anti-cyclic citrullinated peptide (Anti-CCP) antibodies were recorded. Risk factors for cardiac and pulmonary disease, including cigarette use, dyslipidaemia, hypertension, and a personal history of cardiac ischemia were obtained from patient files. Radiographs of the hands and feet were reviewed to assess for erosions.

Chest radiography

The most recent digitalised CXR available on each patient's electronic computer record was systematically reviewed by two investigators (MRG and GC). In order to validate the reporting of these results, a random 10% of CXRs were further assessed by a consultant radiologist (CJ). Concordance was seen in 100% of these cases. In addition, x-rays with inconclusive results were discussed and agreed. Bones (ribs, clavicles, spine, shoulders) were examined for the presence of fractures, tumors, or degenerative disease. Lungs were assessed for hyperinflation, interstitial changes, tumors, or bronchiectasis, while the mediastinum was observed for hilar enlargement. Calcification of the aortic knuckle was noted if present. The cardiothoracic ratio was measured using digital software tools and cardiomegaly was described if the cardiac size at its maximum width was more than 50% of the thoracic width at the same level.

Statistical analysis

Descriptive statistics were reported as mean and standard deviation (SD), median and interquartile range (IQR), or number (n) and percentages as appropriate. For between group comparisons Chi-squared tests were used for categorical variables and independent sample t tests for continuous variables. Statistical significance was set at $p < 0.05$ throughout. Ethical approval was obtained from the Institutional Review Board of St. James's Hospital. All analyses were performed using IBM SPSS Statistics (SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc).

Results

Patients

One hundred and ninety-eight RA patients (143 females and 55 males), with a mean age of 62 years (range 18–90), were included. Mean disease duration was 16 years (range 1–63). One hundred and nine (55.1%) individuals were either ex or current smokers. One hundred and fifty-six (78.8%) had seropositive disease, while erosive changes were visible in 123 (62.1%). One hundred and seventy-nine (90.4%) patients were taking a conventional synthetic disease-modifying antirheumatic drug (csDMARD) and 36 (18.2%) were on a biologic DMARD (bDMARD). Demographic and clinical details are summarized in Table 1.

Table 1 Demographic and clinical details of patients

Characteristic	n = 198
Age, years, mean (range)	62 (18–90)
Female, n (%)	143 (72.2)
Disease duration, years, mean (range)	16 (1–63)
Smokers, n (%)	109 (55.1)
Hypertension, n (%)	72 (36.3)
Ischaemic heart disease, n (%)	25 (12.6)
Seropositive, n (%)	156 (78.8)
Erosions, n (%)	123 (62.1%)
Conventional synthetic DMARD, n (%)	179 (90.4%)
Biologic DMARD, n (%)	36 (18.2%)

DMARD = disease-modifying antirheumatic drug

Radiography

A CXR was available in 163 (82%) cases. Thirty-five individuals (18%) had not had a CXR in the last 6 years. Of the 163 CXRs, 88 (54%) were screening investigations in asymptomatic patients, 75 (46%) were in patients with respiratory symptoms. One hundred and twenty-nine CXRs (79.1%) were abnormal (Fig. 1).

The CXR was sufficiently well-penetrated to visualize the thoracic spine in 152 (93.3%) patients. Of these, 60 (37%) had evidence of multi-level degenerative disease with osteophyte projections to the side of the vertebral column. Scoliosis was present in eight radiographs (5%); there was mild scoliosis in one case (0.6%) and moderate to severe scoliosis in the other seven (4.3%). Rib abnormalities were evident in nine images (6%) which included multiple rib fractures in three cases (2%) and a sclerotic rib lesion in 1 (0.6%). Two radiographs displayed rib crowding (1.2%). Three CXRs with sternotomies (2%) were also categorized as rib abnormalities.

In 113 (69.3%) CXRs, both shoulder joints were visible. Twenty-one (13%) of which showed abnormalities, 19 (11.7%) demonstrated degenerative disease, two (1.2%) had evidence of a humeral fracture, one (0.6%) revealed avascular necrosis, and one (0.6%) had a shoulder replacement. Old clavicular fractures were present in two cases (1.2%).

Cardiomegaly was seen in 37 cases (23%). One individual had dextrocardia. Twenty-four (15%) radiographs showed aortic calcification.

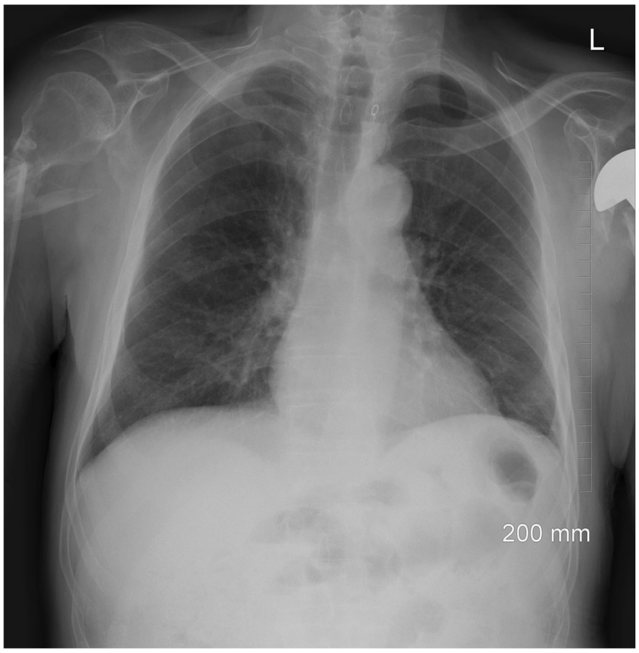

Fig. 1 Chest radiograph of a 63-year-old man with seropositive rheumatoid arthritis. Pathological findings include a displaced fracture of right humerus, left shoulder arthroplasty, linear atelectasis lower lobe left lung, and calcification aortic knuckle

The lungs were abnormal in 71 individuals (44%). Forty-five of 88 (51%) screening CXRs were abnormal compared to 26 of 75 (35%) performed for investigation of respiratory symptoms. Evidence of previous exposure to tuberculosis (TB) was the most common finding, observed in 34 (21%) cases, predominantly in the form of apical pleural thickening or calcified granulomas in the upper lung fields. Other clinically relevant abnormalities included lung hyperinflation in 24 individuals (15%) and interstitial changes in 20 patients (13.3%). Pneumonia was present in two cases (1.2%) and a pneumothorax in one case (0.6%). Four individuals (2.4%) had lung nodules, in three, the final diagnosis was non-small cell lung cancer and in one, a benign pulmonary nodule.

Clinical associations of CXR abnormalities

Chi-squared testing revealed that the incidence of lung abnormalities varied significantly with age ($p = 0.001$) with a higher incidence in middle and old age. There were more lung abnormalities among seropositive patients ($p = 0.044$). There were significantly more lung abnormalities in males ($p = 0.013$) despite a similar proportion of smokers in both sexes. In general, there was no significant difference between smokers and non-smokers in terms of the number and type of lung abnormalities seen in CXRs ($p = 0.177$). However, all cases of pulmonary nodules were observed in seropositive smokers. Cardiomegaly was more commonly found in patients with hypertension ($p = 0.012$) and in those with ischemic heart disease ($p = 0.018$). However, diabetes, dyslipidemia, or smoking history did not correlate with cardiomegaly.

Table 2 Frequency and reporting of CXR abnormalities

Abnormality	Number	Reported	Not reported
Musculoskeletal			
Degenerative spinal disease	60 (37%)	6 (10%)	54 (90%)
Scoliosis	8 (5%)	3 (38%)	5 (62%)
Shoulder abnormalities	21 (13%)	3 (14%)	18 (86%)
Rib fractures	3 (2%)	1 (33%)	2 (67%)
Cardiac			
Aortic calcification	24 (15%)	3 (12%)	21 (88%)
Cardiomegaly	37 (23%)	21 (57%)	16 (43%)
Pulmonary			
Old tuberculosis	34 (21%)	14 (41%)	20 (59%)
Pulmonary hyperinflation	24 (15%)	13 (54%)	11 (46%)
Interstitial changes	20 (13%)	14 (70%)	6 (30%)
Pleural effusion	10 (6%)	8 (80%)	2 (20%)
Bronchiectasis	5 (3%)	4 (80%)	1 (20%)
Pulmonary nodule	4 (2%)	4 (100%)	0 (0%)
Consolidation	2 (1%)	1 (50%)	1 (50%)
Pneumothorax	1 (1%)	0 (0%)	1 (100%)

Aortic calcification was significantly more common with increasing age ($p = 0.022$).

Formal reporting of CXR abnormalities

Overall 154 identified abnormalities in 108 patients (66.3%) were not included in the formal CXR report. The frequency of reporting of selected abnormalities is shown in Table 2. The greatest proportion of unreported abnormalities was seen for those affecting the musculoskeletal system. However, we also found frequent unreported abnormalities affecting the lungs and heart.

Discussion

In this cross-sectional study, 198 RA patients were evaluated for CXR abnormalities. Eighteen percent of this cohort did not have a CXR performed within the last 6 years. Of the available radiographs, potentially clinically relevant anomalies were identified in almost 80%. Formal reporting most commonly alluded to lung pathology, with a reduced frequency of identification of cardiac, cardiovascular, and bony abnormalities. As RA is a multi-system disease, a holistic approach to radiographic reporting has important clinical implications.

A comprehensive analysis of CXR abnormalities in RA has not previously been performed. Dr. de Vries-Bouwstra et al. described the diagnostic value of screening CXRs in 2170 patients with recent-onset arthritis, where just 4% had clinically relevant abnormalities, including lymphadenopathy, sarcoidosis, malignancy, and interstitial lung disease [6]. There was no mention of bony or cardiovascular abnormalities in that cohort. In contrast, 79% of patients evaluated in this study demonstrated potentially clinically relevant findings. These two cohorts are not directly comparable, the Dutch study evaluated patients with early arthritis at the start of their disease, while we have studied the general RA population. The mean age of our patients was 10 years older and there was a significant correlation between the observation of abnormalities and increasing age ($p = 0.001$). However, age, per se, cannot necessarily be blamed for all pathology, particularly when disease is potentially preventable and/or reversible. Forty-four percent had evidence of lung disease, especially old TB. Such a finding is not uncommon in the older Irish population. National data indicate that current rates of TB in Ireland are 10–30/100,000, with increased frequency in urban areas (www.hpsc.ie). This is of great relevance in the consideration of immunosuppressive treatment, particularly with biologic agents [13]. However, only 41% of cases of latent TB present on CXR were identified on their report in this study. More than half the patients in this study were smokers. Fifteen percent of the total cohort had pulmonary hyperinflation, but 46% of these cases were not reported, despite the fact that early identification of chronic obstructive pulmonary disease is essential to symptomatic relief and prevention of infective exacerbations. All four lung nodules were identified, three of which represented a new lung cancer. The association between inflammatory arthritis and malignancy is well-described in the literature [14, 15]. Joint inflammation may be the initial finding in a new malignancy as part of a paraneoplastic presentation, while the rate of cancer in patients with chronic inflammatory disease is higher than in age- and sex-matched controls [14, 15]. It is instructive to compare our results in RA patients to those observed in the general population. The Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial reported the results of four annual chest radiographs in > 70,000 patients [16]. They found abnormalities in 43% of cases, 35% not suspicious for cancer and 8% possibly malignant. The most common abnormalities seen were old TB (10.7% vs 21% in our study), interstitial changes (8.2% vs 13% in our study), musculoskeletal abnormalities (5.5% vs 60% in our study), cardiac abnormalities (4.4% vs 23% in our study), and hyperinflation (2.5% vs 15% in our study). It must be remembered when comparing these two cohorts, however, that the cancer screening patients were a healthy population and had four rather than one radiograph performed.

Aortic calcification is frequently considered to be an incidental finding which increases with age and is therefore rarely reported on CXRs. However, it is a sign of vascular pathology and likely indicates disease elsewhere, particularly in critical supplies to major organs [16]. Cardiovascular disease is the most common cause of death in patients with RA [3]. It is therefore important to identify such abnormalities and perform further risk assessments to neutralize the morbidity and mortality associated with atherosclerosis.

Bony abnormalities on CXR may be considered incidental findings and therefore unimportant in the overall diagnostic process. However, such pathology can be of considerable significance to the patient and a major source of pain or functional impairment. In 37% of cases, degenerative spinal disease could be observed in the thoracic spine. As most did not have a lateral CXR, we could not comment on the presence of diffuse idiopathic skeletal hyperostosis (DISH), which is known to be associated with metabolic disturbance, including diabetes, hypothyroidism, dyslipidemia, and other treatable conditions [17]. Of the eight people with thoracic scoliosis, only three were reported, while shoulder abnormalities, identified in 21 patients were noted in just three. Arthritis patients often under-report their symptoms, but the identification of abnormalities could lead to a more comprehensive history and an effort to relieve suffering through physiotherapy, occupational therapy, or surgery if necessary. The presence of vertebral fractures should prompt an osteoporosis risk assessment and review of relevant treatment.

The 62% of patients with erosive disease in our study may appear at first glance to be high, however, this is when through the prism of modern early RA management. In this study we included patients with variable disease duration including those who developed RA prior to the biologic era. We believe this figure is reflective of the natural history of RA and similar to historic comparators [18, 19].

This study has training implications for all clinicians. It is our opinion that physicians should achieve competency in reading radiographs pertaining to their specialty, instead of relying purely on a report, particularly where the reporting radiologist may be unaware of pertinent clinical details. There is also an obligation on the part of the clinician to ensure that such information is given at the time of ordering of investigations. Increasing digitalization of the ordering process, and the immediate availability of radiology images once performed, greatly assist this process and help to achieve early diagnosis of relevant pathology. The value of a multi-disciplinary conference between clinicians and radiologists cannot be overestimated and provides essential training and interaction that significantly enhances patient care.

As with any study, there are a number of limitations to our work. Chest radiographs were performed where clinically indicated in this study, whether due to symptoms or for screening purposes for biologic agents. This has the potential to introduce selection bias. Ethical standards preclude performing radiographs purely for research purposes, and therefore we believe the best compromise is to present the information found with this caveat to its interpretation. Our study recruited patients with variable disease duration and comorbidities. We believe this is both a strength, in that it increases generalizability to the RA population as a whole, and a limitation as it precludes easy judgements as to which abnormalities are due to RA and which are coincidental and due to other conditions. Finally, while we believe all of the abnormalities we have identified here are of potential clinical importance, the level of intervention actioned is not uniform. A finding of scoliosis clearly has different implications to a potential lung cancer. However, for the individual patient, all of these findings have value in terms of an explanation for their symptoms, a diagnosis, and a management plan.

RA is a systemic disease with clinical implications far beyond the joints [2]. Unrecognized pathology has the potential to result in life-altering or life-limiting illness [3]. It is therefore important to garner information from all possible sources. The routine CXR provides a wealth of opportunity to screen for overt lung, cardiac, cardiovascular, bone, and joint pathology. Comprehensive knowledge of all of the abnormalities present on such radiographs can be of valuable assistance in the holistic approach to the care and treatment of patients with rheumatic disease.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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