Clinical value of $^{18}$F-fluorodeoxyglucose positron emission tomography in patients with connective tissue disease

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Abstract Connective tissue diseases represent a heterogeneous group of immunologically mediated inflammatory disorders with a large variety of affected organs other than the lung. $^{18}$F-fluorodeoxyglucose positron emission tomography (18F-FDG PET) is widely used in oncology but may also be valuable in patients with infections or inflammatory disease. The purpose of this article was to assess the clinical value of 18F-FDG PET in patients with connective tissue disease. Our experience demonstrates that 18F-FDG PET is a unique imaging technique for assessing the metabolic activity throughout the body in those with a connective tissue disease. The technique appears to be a promising imaging modality for detecting coexistent neoplastic diseases and other autoimmune disorders.

Key words 18F-FDG · PET · Connective tissue diseases · Autoimmune disorder · Inflammation

Introduction

Connective tissue diseases (also called collagen diseases) are a pathologic entity whose validity was first established by Klemperer et al. in 1942. The classic collagen diseases include rheumatic fever, rheumatoid arthritis, systemic lupus erythematosus, polyarteritis nodosa, polymyositis/dermatomyositis, and progressive systemic sclerosis. These diseases are based on widespread fibrinoid degeneration of collagen fibers occurring in the mesenchymal tissue. With the rapid progress in immunologic research, connective tissue diseases are now accepted as a complex array of systemic autoimmune disorders that include more than 40 diseases.

A wide armamentarium of clinical, laboratory, and imaging tools is available today for diagnosing inflammation. Anatomic imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI) provide a high-quality assessment of structural abnormalities related to inflammation, and scintigraphic studies have demonstrated early functional impairment due to an inflammatory process. It has long been recognized that 2-deoxy-2-$^{18}$F-fluoro-D-glucose (18F-FDG) accumulates not only in malignant tissues but also at sites of infection and inflammation as well as in patients with an autoimmune disease. However, a systematic assessment of this method for diagnosing nonneoplastic conditions has been undertaken only during the past decade. This article describes the impact of 18F-FDG positron emission tomography
(PET) on the diagnostic workup of patients with connective tissue diseases.

**Image acquisition**

All $^{18}$F-FDG PET examinations were performed with an ECAT EXACT HR+ camera (Siemens/CTI, Erlangen, Germany). This camera acquires 63 planes simultaneously over a 15.5-cm field of view (FOV). In-plane resolution was approximately 4.6 mm, with an axial resolution of approximately 3.5 mm full width at half maximum. Images were acquired in three-dimensional mode. A transmission scan was obtained using a $^{68}$Ge rod source for the purpose of attenuation correction. The emission scan began at 60 min after injection of 185–200 MBq $^{18}$F-FDG. Seven or eight bed positions were used to scan from the skull base to the mid-thigh, with 2 and 3 min allowed per bed position for transmission and emission scans, respectively.

The images were basically acquired with the arms positioned at the side of the body. Additionally, in case of involvement of extremities, affected extremities were imaged. PET images were reconstructed with ordered-subsets expectation maximization (OSEM) using two iterations and eight subsets. Patients were instructed to fast for at least 5 h prior to PET imaging.

**Rheumatoid arthritis**

Rheumatoid arthritis (RA) is characterized by the presence of symmetric arthritis, morning stiffness, and rheumatoid factor in the blood. RA synovitis is characterized by a massive leukocytic infiltrate, proliferative synovial membrane, and neovascularization that gives rise to synovial hypertrophy.

The inflammatory activity of the rheumatoid synovium is visualized in coronal and transverse sections by $^{18}$F-FDG PET. The extent and area of the synovial inflammation are relatively well delineated, and this technique is more informative for detecting inflammation than was conventional radiography. Lung involvement (interstitial pneumonia) occurs in 50% of patients with rheumatoid arthritis. $^{18}$F-FDG is a unique imaging technique that can assess the metabolic activity of lung involvement (Fig. 1). Umeda et al. reported that $^{18}$F-FDG PET was useful for the differential diagnosis and predic-

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**Fig. 1.** A 73-year-old woman had rheumatoid arthritis (RA) associated with interstitial pneumonia. A $^{18}$F-fluorodeoxyglucose positron emission tomography ($^{18}$F-FDG-PET) coronal images reveal strong uptake at the shoulder, elbow, and wrist and moderate uptake in the lower lung. B Bone scintigraphy reveals strong uptake at the shoulder, elbow, wrist, and knee. C Chest computed tomography (CT) shows bilateral irregular linear hyperattenuating areas and ground-glass attenuation in the peripheral lung zones.