Clinical studies concerning the determinants of myocardial $^{201}$Thallium uptake

Klinische Studien über die Determinanten der myokardialen Thalliumspeicherung

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With 8 figures and 4 tables

(Received September 14, 1977)

Summary

Studies were carried out in order to determine the factors influencing myocardial $^{201}$Thallium uptake in man. A total of 158 patients was examined with regard to both $^{201}$Thallium uptake and the assessment of left ventricular and coronary function (e.g. quantitative ventriculography, coronary arteriography, coronary blood flow measurements). The results demonstrate:

1. The $^{201}$Thallium uptake in the normal and hypertrophied human heart is linearly correlated with muscle mass of the left ventricle.

2. The basic correlation between the $^{201}$Thallium uptake and the left ventricular muscle mass is influenced by alterations in both myocardial blood flow and myocardial oxygen consumption.

3. Inotropic interventions as well as coronary dilatation (dipyridamole) may considerably augment the $^{201}$Thallium uptake in accordance with changes in myocardial oxygen consumption and/or in myocardial flow.

4. In disorders with regional wall motion abnormalities (hypokinesis, akinesis, dyskinesis) a progressive decrease in the quantitative $^{201}$Thallium uptake of the left ventricle occurs with increase in the degree of wall motion abnormality.

5. The determination of the quantitative $^{201}$Thallium uptake of the heart enables the evaluation of hypertrophy degree, of regional wall motion abnormalities and of perfusion changes of the myocardium due to primary coronary dilatation and/or metabolically induces flow alteration.

It is concluded that the myocardial $^{201}$Thallium uptake is determined by multiple factors. The major determinants have been shown to include (i) muscle mass, (ii) myocardial flow, (iii) myocardial oxygen consumption. With this regard the clinical data obtained from patient groups with normal ventricular function, with coronary artery disease, with left ventricular wall motion abnormalities and with different degree of left ventricular hypertrophy are correlated with quantitated myocardial $^{201}$Thallium uptake.

Supported by Deutsche Forschungsgemeinschaft.
Myocardial imaging with intravenously administered $^{201}$Thallium has proved clinical value in non-invasively detecting acute myocardial infarction or akinetic and dyskinetic areas of the left ventricle due to chronic coronary artery disease (2–4, 7, 14, 23–26). The scintigraphic visualisation is the consequence of regular $^{201}$Thallium accumulation within the normal and of reduced or abolished $^{201}$Thallium uptake in the ischemic or non-perfused myocardium. Thus, areas with low perfusion may be detected as regions of reduced radioactivity.

The scintigraphic visualisation of regions with reduced $^{201}$Thallium uptake may be appropriate for qualitative myocardial imaging. However, this procedure cannot quantitate the absolute or relative $^{201}$Thallium net-uptake of the whole left ventricle or of a region of interest respectively. In order to quantify myocardial or left ventricular $^{201}$Thallium uptake as well as to evaluate its biological determinants a method is needed which allows quantitation of counts per minute stored in the myocardium.

The clinical studies in this report were aimed at deciding whether (a) other determinants than flow may influence myocardial $^{201}$Thallium accumulation in man and (b) whether assessment of $^{201}$Thallium accumulation in the myocardium by quantitation of counts per minute stored in the myocardium may provide a new diagnostic possibility for non-invasively detecting and quantitating myocardial areas of altered function. The results indicate that flow, ventricular muscle mass and myocardial metabolism play a primary role in $^{201}$Thallium accumulation and that their quantitation may be appropriate for separating patients with altered myocardial function, especially with wall motion abnormalities due to chronic coronary artery disease.

Material and methods

Patient population: 158 patients were examined on the occasion of diagnostic coronary arteriography, ventriculography and left heart catheterization: $n = 105$ with coronary artery disease (CAD) with more than 70 per cent luminal narrowing of at least one major coronary artery, which was partially associated with abnormalities of different degrees of motion of the anterior left ventricular wall ($n = 67$), $n = 7$ with idiopathic hypertrophic subaortic stenosis (IHSS), $n = 5$ with essential hypertension (EH) and significant left ventricular (LV) hypertrophy but with normal coronary arteriogram and normal coronary reserve; $n = 12$ with normal coronary arteriogram, normal coronary reserve and normal LV function; $n = 2$ with marked LV hypertrophy due to aortic incompetence (AI); $n = 6$ with immunologically induced small vessel disease of the heart (lupus erythematosus and progressive scleroderma). In all patients with CAD ($n = 105$) coronary arteriography, left heart ventriculography and quantitative $^{201}$Thallium scintimetry was performed. In 4 normals, in 6 patients with EH and in 2 patients with AI data of quantitative ventriculography including determinations of left ventricular muscle mass (LVMM) and total LV oxygen consumption were correlated with data of quantitative $^{201}$Thallium scintimetry ($n = 12$). In 5 normals, in 3 patients with EH and in 10 patients with CAD coronary blood flow, coronary reserve and LV oxygen consumption were determined ($n = 16$). In addition to these groups, 20 patients with acute myocardial infarction (AMI) of the anterior LV wall were studied with regard to non-invasive $^{201}$Thallium scintimetry.