Abstract
At the Fall meeting of the Insurance Medical Group of New England held on November 17, 1978, the guest speaker, Joseph P. Liss M.D., F.A.C.C. spoke on the “Old and New Techniques Utilized in the Non-Invasive Diagnosis of Coronary Artery Disease”. He is the Director of Cardiac Rehabilitation and the Chief of the Exercise Laboratory at St. Francis Hospital and Medical Center, Hartford, CT.

Dr. Liss’ stimulating presentation was delivered from the following salient material.

CATEGORIES OF THE GRADED EXERCISE TEST RESULTS
a. Normal tests
b. Uninterpretable tests
c. Mildly, moderately and strongly positive tests.

THE GRADING SYSTEM

1. Normal ECG Response (negative test)
   a. Absence of any change in the ST segment at maximal or near maximal heart rate.
   b. Junctional depression with rapidly rising ST slope.
   c. Development of isolated T-wave inversion without ST segment displacement.
   d. Ventricular ectopic beats.
   e. Appearance of atrial arrhythmias.
   f. Development of right bundle branch block.

2. Uninterpretable Exercise Test Responses
   a. Failure to attain at least 85% of age-predicted maximum heart rate with absence of ischemic changes in the well-motivated patient.
   b. Presence of baseline ECG abnormalities.
   c. Drugs, i.e.: digitalis, diuretics and psychotropics.
   d. ECG abnormalities, i.e.: LBBB, RBBB, WPW, LVH.
   e. Poor ECG recordings.

3. Mildly Positive Electrocardiographic Response
   a. Horizontal ST segment depression between 1 and 1.5 mm.
   b. Junctional depression with slowly rising ST slope that remains depressed 1.5 mm. or more 80 milliseconds after the J-point.

4. Moderately positive ECG Response
   a. Horizontal ST segment depression between 1.5 and 2.5 mm.
   b. Slowly upsloping ST segment depression with the ST segment being depressed in excess of 2.5 mm. 80 milliseconds after the J-point.
   c. Downsloping ST depression with the J-point depressed 1 to 2 mm.
   d. Frequent ectopic activity especially occurring at rates less than 130 and when associated with ischemic ST segment abnormalities.

5. Strongly Positive ECG Response
   a. Downsloping ST segment depression, the J-point depressed 2 mm. or greater.
   b. Downsloping or flat ST segment depression in excess of 2.5 mm.
   c. Horizontal or downsloping ST segment depression appearing in the first stage of exercise and-or persisting beyond 8 minutes in the recovery phase.
   d. Complex ventricular ectopic activity including multiform ventricular ectopic beats, salvos or runs of ventricular tachycardia or recurrence of ventricular fibrillation.

COMPARISON OF THE VARIOUS METHODS OF STRESS ELECTROCARDIOGRAPHY
Dr. Helfant, in 43 patients with arteriographic evidence of coronary artery disease, found:
52% were abnormal on exercise ECG;
79% were abnormal using Thallium testing;
84% were abnormal on first pass radionuclide cineangiography.

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INDICATIONS FOR FIRST PASS IMAGING AFTER GRADED EXERCISE STRESS ECG
a. Patients who present with chest pain and early evidence of Coronary Artery Disease, but do not yet have evidence of clear-cut symptoms of angina pectoris.

Dr. Helfant
July-August 1978

INTERPRETATION OF THE GRADED STRESS TESTS
a. Assessment of ECG abnormalities developing during exercise and their relationship to myocardial ischemia.
b. The clinician’s evaluation of observations made during the test, and appreciation of variables pertaining to the patient which could influence the final interpretation.

VALUE OF THE GRADED EXERCISE TEST
a. Identification of patients with precarious degrees of coronary artery stenosis.
b. The selection of patients in whom coronary arteriography may be indicated.
c. To collect follow-up data in patients after myocardial infarction or aortocoronary bypass surgery.
d. An adjunct in recommending and planning an exercise rehabilitation program.

e. Mitral valve prolapse.
f. Hypertension.
g. History of pericarditis.
h. Pectus excavatum.
i. Conduction abnormalities - i.e. WPW, LBBB.
j. Syndrome X.
k. Vasoregulatory asthenia.
l. Cardiomyopathy.
m. Infiltrative heart disease.
n. Myocarditis.
o. Anemia.
p. Hyperventilation.
q. Non-fasting state.
r. Amplified TA wave.
s. IHSS.

IMPROVING THE EFFICIENCY OF THE GRADED EXERCISE TEST

100 Cases
Sensitivity
Specificity
V5 BL 14L
56% 77% 88%
94% 82% 82%
96% of patients with triple vessel disease are detected.

NOTE: BL = Bipolar Leads; 14L = Includes XYZ leads.

Chaitman et al Chest Circulation III-7, 77

REASONS FOR FALSE NEGATIVE EXERCISE TESTS
a. Differences in patient populations studied.
b. Methodologies.
c. Criteria used for abnormal ST segment depression.
d. Definition of “significant” coronary artery obstruction by coronary angiography.
e. The state of the baseline electrocardiogram.
f. Poor history and physical.
g. Rate dependent LAH.
h. Baseline LAH.
i. Prior use of medications such as Isordil and Inderal.
j. Use of a single lead system.

REASONS FOR FALSE POSITIVE EXERCISE TESTS
a. Improper history and physical examination.
b. Medications - i.e. digitalis, diuretics, psychotropic drugs.
c. Rheumatic valvular disease - i.e. mitral stenosis.
d. Congenital heart disease - i.e. aortic stenosis, pulmonary hypertension.

e. Mitral valve prolapse.
f. Hypertension.
g. History of pericarditis.
h. Pectus excavatum.
i. Conduction abnormalities - i.e. WPW, LBBB.
j. Syndrome X.
k. Vasoregulatory asthenia.
l. Cardiomyopathy.
m. Infiltrative heart disease.
n. Myocarditis.
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MEASUREMENTS AVAILABLE WITH RADIONUCLIDE CINEANGIOGRAPHY
a. Right and left ventricular volumes.
b. Right and left ventricular ejection fractions.
c. Right or left ventricular hypertrophy.
d. Flows at rest and exercise.
e. Delayed filling.
f. Right and left ventricular shunts.

VENTRICULAR FUNCTION WITH EXERCISE
a. The ejection fraction increases with exercise in normals.
b. The ejection fraction with Coronary Artery Disease falls or fails to change.

SENSITIVITY OF TI 201 IN MYOCARDIAL INFARCTION
LAD 100%
RCA 77%
CIRCUMFLEX 60%

Wagner 1978

MAIN INDICATIONS FOR TI 201 IMAGING
a. Asymptomatic patients with a positive exercise test.
b. Equivocal or uninterpretable studies.
c. Patients with angina and negative stress studies.
d. Pre-operative assessment of Coronary Artery Disease.
e. Document effects of bypass surgery.

END-POINTS DURING CLINICAL GRADED EXERCISE TESTING
a. Maximal level of O2 uptake.
b. Chest pain.
c. Symptoms or signs of cerebral ischemia.
d. undue or unusual S.O.B., weakness, fatigue, pallor or cyanosis.
e. Fall in blood pressure or heart rate with increasing work or blood pressure greater than 250 systolic or 120 diastolic.
f. Claudication.
g. Significant ECG abnormalities if not present at rest.
h. Progressive ST depression greater than 1 mm (0.1 MV).
i. Progressive ST segment elevation.
j. Serious dysrhythmias: PVCs; greater than 10/min; multifocal PVCs runs of 2 or more PVCs; sustained atrial arrhythmia or AV block.

SCREENING FOR OTHER CONDITIONS WITH TI-201

a. Known Coronary Artery Disease of uncertain extent clinically or by angiography.
b. Those in whom the coronary angiogram or ventriculogram do not provide complete information.
c. Long-term non-invasive follow up of pts. with known Coronary Artery Disease. Enlarged defects or new defects would indicate progression of disease.
d. Assessing the effects of coronary artery bypass surgery.

TI-201 PHYSICAL PROPERTIES

a. Decays by electron capture process to 201 Hg.
b. Produces both X and gamma radiation.
c. Physical 1/2 life is 73.1 hours.
d. X-rays 167.4, 163.9, 135.3 ke V.
e. X-ray of 30 to 70 ke V peak 80.
f. Hg x-rays = 88% of emissions.
g. Produced by a cyclotron.
h. Distribution in the myocardium.
   1. coronary blood flow
   2. Na-K-ATPase, 02
i. Redistribution in 2-4 hours scanning time critical.

1978

OTHER VALUES OF TI-201 SCANS

a. With normal septal perfusion proximal LAD disease is unlikely.
b. Gated TI-201 scans provide a more sensitive method for detection of IHSS.
c. TI-201 imaging lends evidence that transluminal angioplasty of coronary artery stenosis is effective in improving compromised myocardial perfusion during exercise.

DUAL IMAGING WITH TI 201 AND PYROPHOSPHATE

b. Apply early in diagnosis.
c. Right ventricular infarction in 37.5% of inferior wall infarction.
d. TI 201 45 degrees; pyrophosphate LAO.
e. Volume loading maybe life-saving.

SINGLE DOSE AND DOUBLE DOSE TI 201 MYOCARDIAL SCINTIGRAPHY

a. Detection of ischemia requires comparison of scintigram at rest and with exercise.
b. On exercise scintigrams ischemic areas appear as new or larger defects.
c. Areas of residual myocardial infarction appear as defects on both resting and exercise scintigrams.
* d. Redistribution occurs within 4 hours.

THALLIUM POISONING

A detailed description may be found in The Pale Horse by Agatha Christie.

RADIOACTIVE TRACERS

1927 - Blumgart & Weiss.
1964 - Carr et al.
1966 - Quinn et al.
1974 - Zaret - exercise induced ischemia.

REGIONAL TI-201 UPTAKE

Dependent on: 02, Na-K-ATPase, blood flow.

TI-201 IN RIGHT VENTRICULAR INFARCTION

a. Assess with imaging with TI-201 and Tc 99m pyrophosphate.
b. Non-invasive method of recognition of hemodynamic deterioration due to major right ventricular involvement.

EARLY AMBULATION IN THE PATIENT WITH ACUTE MYOCARDIAL INFARCTION

Long continued bedrest saps morale, provokes desperation, unleashes anxiety, and ushers in the hopelessness of the capacity of resuming a normal life.

Levine, Boston

REASONS FOR EXERCISE TESTING WITH TI-201 IN CORONARY ARTERY BYPASS SURGERY

a. Objective means of evaluating cardiac performance.
b. Increase in exercise duration, no pain and resolution of ST depression correlate with patency.
c. Rest and exercise TI-201 images more specific for evaluating regional myocardial flow and graft patency (performed pre and post-operatively).
d. Detect new or post-operative exercise defects as graft dysfunction, perioperative infarction or residual ungrafted disease in the area of new defect.
REASONS FOR TI-201 IMAGING IN NON-CORONARY HEART DISEASE

a. Detect pressure overload (aortic stenosis) concentric hypertrophy small chamber.
b. Detect volume overload (AI, MR).
c. Asymmetrical hypertrophy (cardiomyopathy) 45 degrees LAO triangular shape and thickened septum.
d. Right ventricular hypertrophy more reliable than ECG.
e. Pericardial effusion.

CLINICAL APPLICATION OF TI-201 CCU

a. Selection of patients for the CCU.
b. Diagnosis during acute initial stage.
c. Precise localization of perfusion defect.
d. Approximate estimation of infarct size.
e. Diagnosis in presence of LBBB, WPW, etc.
f. Confirmation of previous infarct.
g. Configuration and size of left ventricle.

ADVANTAGES OF MYOCARDIAL IMAGING

a. Non-invasive.
b. Risk-free.
c. Information on regional blood flow at rest and with exercise.
d. Information not obtainable from coronary arteriography (anatomic).

LIMITATIONS OF TI-201 IN ACUTE INFARCTIONS

a. Inability to distinguish new infarcts from old infarctions.
b. Inability to perform studies more often than 2-3 days.
c. Segments of 5 grams or less with flow less than 50% are not identified.

TI-201 MULTICENTER STUDY IN ANGINA PECTORIS AND MYOCARDIAL INFARCTION

a. 190 patients in 5 centers.
b. Imaging complements ECG identification of acute infarction or exercise-induced ischemia.
c. Detection of coronary artery disease in 91% with angiographically documented coronary artery disease.
d. Applies to different populations and image interpreters.

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RATE OF REDISTRIBUTION OF TI-201

a. Rate of redistribution is inversely related to degree of coronary artery stenosis.
b. Redistribution may be very rapid in patients with mild to moderate coronary artery lesions.

c. For maximal sensitivity imaging must begin immediately after exercise.
d. Late redistribution imaging helps avoid false diagnosis of myocardial infarctions.

1978

We are grateful to Dr. Liss for permitting us to publish his outline in Insurance Medicine.

From The Journals

by John A. Kilgour, M.D.
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The following commentary was received from Dr. Chris A. West, Medical Vice President of Canada Life, which will be of interest to our colleagues.

CARBOHYDRATE INTOLERANCE ASSOCIATED WITHATHEROMA AND MORTALITY

At the 1975 meeting of ALIMDA, in answer to Dr. Warren Kleinsasser's vital question, we were told that there was no evidence of increased mortality with carbohydrate intolerance in the absence of diabetes. It was also noted that any articles to confirm or deny this were difficult to find.

There have been several articles with retrospective studies indicating that those with abnormal glucose intolerance do have increased coronary atherosclerosis. One very interesting and precise article, however, was published in 1972 by Dr. Christopher Hardwick in the Assurance Medical Society Journal in London. He commented on Prof. Keen's work, which was published a few years later, indicating that there was a very definite difference in complications in those which we have previously labelled as borderline abnormal BSTT tests, or in those specifically with 2-hour p.c. sugars which were above normal, but not definitely diabetic. In this group, who were meticulously followed for 7 years, there was a very definite increase in those diseases associated with atheroma, and almost double the mortality found in the control group. There was also, of course, a much greater increase in both, complications and mortality in known diabetics.

It suggests, therefore, that one cannot separate normal glucose intolerance strictly from abnormal, but that complications and mortality vary throughout the whole spectrum.