HIGH RESOLUTION IMPEDANCE CARDIOGRAPHY FOR THE
DETECTION OF CORONARY DISEASE DURING STRESS TESTING

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An electrode-based technique for the monitoring of left
ventricular performance under stress would be desireable.
We compared R-wave triggered, ensemble averaged thoracic
electrical impedance cardiograms, Doppler ultrasound left
ventricular ejection profiles, and radionuclear ejection
fractions (EF) in 31 male patients of age 62 ± 12 years
during graded treadmill and supine bicycle stress testing.
Subsequent coronary arteriography revealed Gensini coronary
scores >16 in 26 (CAD: range 28 to 196), while 5 had scores
$\leq$16 (NML). Treadmill Impedance and Doppler ensemble
averages (20 or more beats) were indexed by the maximal
systolic deflection (velocity: Zmax and Dmax), and the
average rate of systolic change (acceleration: Zacc and
Dacc). We compared percent changes (%▲) from rest to peak
exertion in CAD and NML groups; *p<.05, **p<.001:

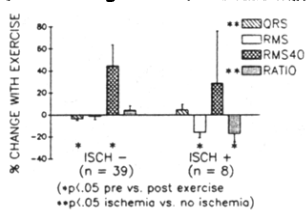|	Max HR	DP	%▲Zmax	%▲Dmax	%▲Zacc	%▲Dacc
NML	138+10	272+25	59+13	77+15	234+28	187+38
CAD	120+16	244+20	38+11*	29+13**	75+24**	80+31**

Despite similar maximum heart rates (Max HR) and double
products (DP) achieved by CAD and NML patients, CAD
responses were distinguished by impaired augmentation of D
and Z deflections during exercise stress. %▲Dacc and
%▲Zacc correlated with exercise EF (r=.70 and r=.72). High
resolution impedance cardiography, like Doppler ultrasound,
may be useful in the detection of CAD by the evaluation of
left ventricular performance under stress.

VISUAL VS. COMPUTER BASED EXERCISE TEST INTERPRETATION.

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Visual (V) and computer (C) interpretations were
compared in 120 consecutive maximal modified Bruce
protocol exercise tolerance tests performed on the
identical treadmill system in eight VA Medical Centers
participating in the ACME Study which compares
angioplasty to medical therapy in patients with
angiographically proven coronary artery disease. Visual
readings consisted of a consensus from three trained
individuals blinded to the computer results. A test was
considered visually positive if $\geq$ 1.0 mm ST segment
depression was detected 0.08 sec after the j point
during or immediately after exercise in any of the
following leads: I, II, III, aVF, V_1-V_6. The ST
segment depression had to be present on two successive
ECGs and appear during or after exercise. Computer
readings were based on median averaged beats recorded
every 15 sec and involved the same fiducial points,
leads, and criteria for positivity described above.
Median averaged beats were defined by an electronic
algorithm. There was an 86% agreement for V vs. C
interpretations [103/120 (both +, n=58; both -, n=45)].
The 14% disagreement involved V-, C+ in 13 cases (10.7%)
and V+, C- in 4 cases (3.3%). This treadmill system and
computer algorithm using median averaged beats is a
reasonable surrogate for visual interpretation of the
exercise ECG in the majority of patients in the ACME
Study having single and double vessel coronary artery
disease.

SIGNAL AVERAGED ELECTROCARDIOGRAPHY TO DETECT EXERCISE
INDUCED MYOCARDIAL ISCHEMIA

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To investigate the effects of exercise induced ischemia on the the signal
averaged electrocardiogram (SAE), we acquired SAE's (40 Hz bidirectional
high pass filter, vector magnitude plot) before and immediately after
thallium treadmill testing in 47 patients with chest pain. Changes in QRS
duration (QRS), total QRS root mean square voltage (RMS), and terminal
40 msec RMS voltage (RMS40) were analyzed. RMS40 increased in
nonischemic patients while ischemic patients showed no change.
Nonischemic patients had QRS shortening and no significant change in
RMS, while ischemic patients had no change in QRS and a decrease in
RMS. Because of these opposing effects on QRS and RMS in ischemic
vs. non-ischemic patients, the ratio RMS/QRS was calculated. The mean
percent change (± 1 standard deviation) in SAE measurements and
RMS/QRS ratio are shown graphically. The change in RMS/QRS ratio with
exercise was the best discriminator
between ischemic and non-
ischemic patients. A change in
RMS/QRS ratio of <-0.16 µV/msec
was 75% sensitive and 77%
specific for detecting ischemia
(defined as thallium redistribution),
exceeding the utility of the 12 lead
ECG in this group. We conclude:
1) quantitation of the effects of
exercise-induced ischemia on the QRS is possible using the SAE, 2)
exercise without ischemia in this group decreased QRS and did not
change RMS and RMS/QRS ratio; 3) ischemia during exercise decreased
RMS and RMS/QRS ratio; 4) changes in the SAE with exercise may be
useful in the diagnosis of ischemia and warrant further investigation.

A NOVEL ACTIVITY METER ASSESSED IN THE
CORONARY CARE UNIT.

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The assessment of daily activity is notoriously difficult
in man. The NYHA classification is crude and
questionnaire based assessments are time consuming. We
have assessed a novel activity meter. Each device is
37x14x30mm, weighs 21g and incorporates a mercury-in-
glass microswitch, solid state memory, small power supply
and an LED display which can be activated by an external
power supply. 4 meters were attached to each subject, in
perpendicular pairs: longitudinal and across a wrist,
longitudinal and across the lateral aspect of an ankle.
32 periods of 24hr were recorded from 25 patients
undergoing our routine post myocardial infarction
rebobilisation regimen. Mean total (4 meter) 24 hour
counts rose daily: Day1 3932±865, Day2 6728±744, Day3
6884±990, Day4 8632±1067, Day5 12151±1029 (1v5 p<0.001,
1v2 p<0.05, 4v5 p<0.05). The leg (2 meters) counts showed
a daily rise from Day2 (p<0.05) when the subjects were
out of bed. The arm (2 meters) counts rose only after
Day1 (p<0.05) and then reached a plateau, suggesting
that the patients had reached the steady state of arm
activity for hospital in-patients. A further 43 patients
underwent Bruce exercise tests with meters attached. 13
stopped during Stage 2. The correlation between exercise
time and total leg count was significant for Stage 2
(Spearman r=0.87, p<0.001). The results indicate that
these novel activity meters can detect relatively small
changes in daily activity and that they should be useful
in assessing subjects in their own homes.