tioxidant activity and induction of the anticarci-
nogenic phase II marker enzyme quinone reduc-
5. Jackson P, Loughrey CM, Lightbody JH, McNanee PT, Young IS. Effect of hemodialysis on total antioxidant capacity and serum antioxi-
7. Cole DF. Comparative aspects of the intracu-

W. Russell McLauchlan1*
Julie Sanderson2
Michael Quinlan3
Gary Williamson1
1 Dept. of Biochem.
Inst. of Food Res., Norwich Lab.
Norwich Res. Park
Colney, Norwich
Norfolk NR4 7UA, UK
2 School of Biol. Sci.
Univ. of East Anglia
Norwich, Norfolk NR4 7TJ, UK
3 Dept. of Ophthalmol.
West Norwich Hospital
Bawthorpe Road
Norwich, Norfolk NR23SR, UK

*Author for correspondence. Fax 44-
1603-507723; e-mail russell.mclauchlan@ bbsrc.ac.uk.

Cardiac Troponin I in Myocardial
Contusion

To the Editor:

Myocardial contusion (MC) is de-
defined as cellular damage that results
from nonpenetrating chest trauma.
MC is the most common cause of
morbidity and mortality in patients
who have had chest trauma. Diagnosis
of MC is laborious, and chest
pain, dyspnea, and nonspecific
electrocardiograph changes are
commonly present in patients with
chest injury. Although transesophageal
echocardiography (TEE) can provide
high quality images for diagnosis
(1, 2), noninvasive diagnosis of this
lesion has been always problematic.
Cardiac enzyme activity is not com-
nonly used for MC diagnosis. In
recent years, the development of as-
says using new, highly cardiac-spe-
cific proteins has opened new fron-
tiers for the diagnosis of myocardial
cell damage. Cardiac troponin I
(cTnI) is a small filament-associated
regulatory protein of muscle,
uniquely specific for the heart
(3).
cTnI is not expressed by developing
or diseased human skeletal muscles,
even when the skeletal muscle crea-
tine kinase MB isoenzyme (CK-MB)
concentration is increased (4).

We measured cTnI and CK-MB
mass by immunoassay (Stratus,
DADE International) in 28 consecu-
tive patients (23 men and 5 women;
ages 43.8 ± 20.5 years, mean ± SD)
who had been admitted for chest
injury; patients with previous histories
of cardiac diseases were excluded.

After admission, patients under-
went a TEE, and the images were
interpreted by an expert echocardi-
ographer who was unaware of the
biochemical results. The presence of
a segmental wall-motion abnor-
mality, which resolved on a subse-
quent echocardiogram, or a fixed segmen-
tal asynergy associated with the de-
velopment of new Q waves on the
electrocardiogram were used as the
prospective criteria for diagnosing
MC. Kinetics of the right ventricular
antero-apical wall and the left ven-
tricular apex were particularly exam-
ined (5). Serial blood samples were
obtained from patients 6, 12, 24, 48,
and 96 h after chest injury. Five
patients showed evidence of MC
(18%) by TEE imaging; among
these, temporary regional dysfunc-
tion was documented in four pa-
tients, whereas only one patient
showed a fixed regional asynergy
associated with the appearance of
new Q waves. In all five patients,
serum cTnI and CK-MB were in-
creased, with medians and ranges
that were 2.4 μg/L (1.2–5.5 μg/L)
and 14.5 μg/L (6.9–24.8 μg/L), re-
spectively. No myocardial lesions
were found by TEE investigation in
the remaining 23 patients. Within
this group, cTnI was undetectable
(<0.4 μg/L) in 16 patients; in the
other patients, the median cTnI
concentration was 0.8 μg/L (0.5–1.1
μg/L). The CK-MB concentration
was within the reference range (<6
μg/L) in 10 of these 23 patients but

Fig. 1. Receiver operating characteristic curves of cTnI and CK-MB (P.S.P. 4.2).
The area under the curve for cTnI was 0.9857 (SE, 0.071); the area for CK-MB was 0.7143 (SE, 0.11),
P <0.05. Numbers on the curve indicate selected cutoff concentrations in μg/L.
increased in the other 13 (mean, 14.5 μg/L; range, 6.9–24.8 μg/L). No correlation was found between cTnI and ST-segment changes. Electrocardiograms showed ST-segment alteration in two patients with echocardiographic signs of MC and in two patients without MC signs.

cTnI concentrations peaked between 6 and 12 h after chest trauma and disappeared 48–96 h after the trauma. Thus, the diagnostic window was narrower than it is during acute myocardial infarction, probably because of the lower peak serum concentration of cTnI.

We conclude that:

- The incidence of MC in our patients was 18%, as detected by TEE investigation.
- All of the MC patients had a positive cTnI test (>0.4 μg/L).
- The cTnI assay is more specific than CK-MB for MC after chest injury. The receiver operating characteristic curve shows the clinical performance of the two markers. Assuming that the cutoff concentrations for cTnI and CK-MB are 1.1 μg/L and 18 μg/L, respectively, these markers showed 100% (0.83–1.0 μg/L) and 80% (0.56–0.95 μg/L) specificity (Fig. 1).
- cTnI >1.1 μg/L indicates a cardiac lesion observable through TEE.
- Other authors have reported different cTnI cutoff concentrations that are >1.1 μg/L; the discrepancy is probably due to a different mode of echocardiographic investigation (6).
- Serum cTnI concentrations of 0.4–1.1 μg/L could be indicative of microlesions of cardiac tissue not detectable by echocardiography.

References

Agostino Ognibene1*
Fabio Mor1
Roberto Santoni2
Alfredo Zuppiroli3
Adriano Peris4
Giacomo Targioni2
Alberto Dolara3

1 Laboratorio di Endocrinologia
2 Clinical Chemistry Laboratory,
3 U.O. Cardiologia 2
4 Laboratorio di Endocrinologia
5 Clinical Chemistry Laboratory,
Azienda Ospedaliera Careggi
Toscana, Italy
Ospedale S. SMA Azienda 10
Firenze, Italy.

Combined Use of Markers of Muscle Necrosis and Fibrinogen Conversion in the Early Differentiation of Myocardial Infarction and Unstable Angina

To the Editor:

Intracoronary formation of blood clots on ruptured arteriosclerotic plaques is considered the main cause of acute myocardial infarction (AMI) (1). After such ruptures, exposed tissue factor binds to factor VIIa from plasma, and the resulting tissue factor-factor VIIa complex activates factor X toward factor Va, the enzyme converting prothrombin to thrombin. By cleavage of fibrinopeptides A and B, thrombin produces desAABB-fibrin monomers that polymerize into still-soluble complexes called “thrombus precursor proteins” (TpPs). New antigens formed on these complexes were used for a TpP assay (2).

Because the acute thrombotic event precedes coronary occlusion and muscle necrosis, detection of activated coagulation potentially allows early detection of AMI. Until now, attempts in this field have focused on markers for factor Xa and thrombin activity, such as prothrombin fragment 1.2 and thrombin-antithrombin complexes. However, these markers are not necessarily closely related to the actual formation of fibrin clots (3), especially in chronically hypercoagulable patients, and TpP could perform better in this respect. We therefore studied plasma concentrations of TpP and fibrin monomers (FMs) in patients with suspected AMI. The results were compared with two small cytosolic cardiac marker proteins, myoglobin (Mb) and fatty acid-binding protein (FABP), that are early markers for necrosis (3, 4) and with a highly cardiосpecific marker, troponin I (TnI).

TpP was determined with a monoclonal sandwich ELISA provided by American Biogenetic Sciences (2). Intraassay imprecision, estimated on three different days by the 11-fold determination of three pools of citrated plasma with 2.9, 10.1, and 20.7 mg/L of TpP added, was 16%, 11%, and 12%, respectively (CVs). Interassay imprecision, estimated from duplicate measurements on 20 different days of citrated donor plasma and similar plasma with added TpP, was 23% and 30%, respectively, with mean values of 2.5 and 11.6 mg/L. FMs were determined with a sandwich ELISA (Boehringer Mannheim). The assay measures the free amino terminus of fibrinogen Aα-chains. Mb was determined with an immunoturbidimetric assay (Hoffmann-La Roche); FABP was determined with a monoclonal sandwich ELISA as described (3, 6), creatine kinase MB isoenzyme (CK-MB) was determined with a microparticle immunoassay (Abbott), and TnI was determined with a one-step sandwich ELISA (Boehringer Mannheim). ROC curves were obtained from double logarithmic plots (7).