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Relative Role of NT-pro BNP and Cardiac Troponin T at 96 hours for Estimation of Infarct Size and Left Ventricular Function After Acute Myocardial Infarction

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ABSTRACT

***Background*: N-terminal brain-type natriuretic peptide (NT-pro BNP) and cardiac troponin T (cTnT) after acute myocardial infarction (AMI) have proven useful for prediction of prognosis and may be valuable for assessment of left ventricular function and infarct size. The aim of the present study was to correlate infarct size and left ventricular function determined by cine and late gadolinium enhanced CMR with plasma levels of TNT and NT-pro BNP levels after AMI. *Methods*: We studied 44 patients (pts) with first ST- and non-ST-segment elevation myocardial infarction (STEMI = 23 pts.,NSTEMI = 21 pts.). We measured NT-pro BNP and cTnT on a single occasion at 96 hours after onset of symptoms. *Results*: There was a moderate inverse correlation between NT-pro BNP and LV-EF in STEMI ($r = -0.67$, $p = 0.0009$) and NSTEMI ($r = -0.85$, $p < 0.0001$). Likewise, cTnT showed a significant inverse correlation with LV-EF in STEMI ($r = -0.54$, $p = 0.014$) but not in NSTEMI. With cTnT there was a strong linear correlation with infarct mass and relative infarct size in STEMI ($r = 0.92$, $p < 0.0001$) and NSTEMI ($r = 0.59$, $p < 0.0093$). NT-pro BNP demonstrated a good relationship with infarct mass ($r = 0.79$, $p < 0.0001$) and relative infarct size ($r = 0.75$, $p < 0.0001$) in STEMI, but not in NSTEMI. *Conclusion*: A single NT-pro BNP and cTnT value at 96 hours after onset of symptoms proved useful for estimation of LV-EF and infarct size. In direct comparison, NT-pro BNP disclosed a better performance for estimation of LV-EF whereas cTnT was superior for assessment of infarct mass and relative infarct size, suggesting an implementation of a dual marker strategy for diagnostic and prognostic work-up.**

INTRODUCTION

After AMI, prognosis is closely related to the extent of myocardial necrosis and the resulting hemodynamic compromise of LV function (1). In clinical practice, infarct size and LV function are estimated non-invasively using different imaging techniques that suffer from inadequate resolution, limited availability or high costs (2). Among these techniques, late gadolinium-enhanced cardiovascular magnetic resonance (LGE-CMR) has demonstrated superior performance regarding visualization of infarct size and quantification of LV function (3), allowing even the quantification of very small infarcts following percutaneous coronary interventions (4–6).

Biochemical markers such as NT-pro BNP and cTnT have gained increasing attention for their ability to predict prognosis across the whole spectrum of acute coronary syndromes (7–9).

NT-pro BNP is being secreted by ventricular myocardium in response to increased myocardial stress and hemodynamic compromise (10). The relationship between elevated natriuretic peptide levels and survival is believed to result mainly in their reflection of increased LV filling pressure secondary to LV dysfunction (11). In patients with AMI, plasma NT-pro BNP measured 48 to 120 hours after the index event has been shown to correspond with LV function and long-term survival (12, 13).

cTnT is a structural protein of the contractile apparatus that is exclusively expressed in cardiomyocytes (14). Numerous clinical trials have established its role for diagnosis of AMI and risk

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stratification of acute coronary syndromes without ST-segment elevation (15). In addition, there is convincing evidence from several trials that cTnT is also useful for risk stratification in STEMI (16–18). More recently, several experimental studies (19, 20) and clinical trials (21) demonstrated that a single cTnT value measured 72–96 hours after the onset of symptoms was useful for estimation of infarct size and proved at least as effective as multiple measurements of cardiac enzymes for assessment of cumulative release or peak values.

The aim of the present study was to investigate the ability of a single NT-pro BNP and cTnT value at 72–96 hours after the onset of symptoms to predict LV function and estimate infarct size. NT-pro BNP and cTnT levels were related to LV-EF and infarct size measured by LGE-CMR.

METHODS

During July 2004 and March 2005, we enrolled 44 patients admitted to the chest pain unit of the University of Heidelberg with AMI, which was diagnosed in accordance with the definition criteria of the ESC/AHA Task Force (22). AMI without ST-segment elevation (NSTEMI) was defined by an elevation of cTnT above 0.04 μglL on at least one occasion within 24 hours after the ischemic index event with a rise or fall during subsequent sampling. AMI with ST-segment elevation (STEMI) was defined by elevation of the ST-segment $>$ 0.1 mV in at least two contiguous leads or new onset of left bundle branch. Primary or early PCI was attempted in 42 of 44 patients and was deemed successful in 41 patients. Blood samples were taken on admission and 72–96 hours after onset of ischemic symptoms. After centrifugation, the samples were stored at -20°C until assayed. The study protocol was approved by the institutional ethical committee, and patients gave written informed consent.

Measurement of cTnT

Blood was collected in the morning of either the third or fourth day (Median 90 h [IQR 77; 96]; Range: 70–108 h). For practical reasons, a time span between 72 and 96 hours after the onset of symptoms rather than a fixed time point was used in the following.

cTnT was measured quantitatively using a one-step EIA based on electrochemiluminescence technology (3rd generation cTnT, Elecsys 2010, Roche, Mannheim, Germany). The lower detection limit of this assay is 0.01 μg/L with a recommended diagnostic threshold of 0.04 μg/L. The inter-assay coefficients of variation (between day imprecision data set of at least 11 runs) at different concentrations were 20% for 0.015 μg/L, 10% for 0.04 μg/L, and 5% for 0.08 μg/L.

Measurement of NT-pro BNP

Likewise, NT-pro BNP levels were measured after a median of 90h (IQR 77, 96; Range: 70–108 h). After centrifugation, plasma samples were stored at -20°C until measurement. The Roche NT-pro BNP assay employs two polyclonal antibodies aimed at epitopes on residues 1–21 and residues 39–50. One is labelled to biotin and the second with a ruthenium complex. The latter binds to the NT-pro BNP to form a sandwich. Thawed plasma samples were analyzed using the commercially available sandwich immunoassay on a fully automated analyzer (NT-pro BNP ELECSYS 2010, Roche Diagnostics, Mannheim, Germany). Performance characteristics are a % CV of 3.2–2.4% from 175–4962 ng/l with an analytical range of 5–35.000 ng/L.

CMR protocol

CMR was performed after a median of 4 days (IQR 3, 4; range: 1 to 7 days). Patients were placed in supine position in a 1.5 T Whole Body CMR scanner (Philips Medical Systems, Best, Netherlands) employing a four lead Vector-ECG with retrospective gating and a specific five element cardiac phased-array receiver coil positioned on the chest of the patient. Vital parameters like blood pressure, heart rate and respiration curves were monitored continuously using Physio Trak (Philips Medical Systems, Best, Netherlands). Initially, ultra-fast sagittal, transverse and coronal survey scanning of the patient's thorax as well as acquisition of reference images of the coil sensitivity for parallel imaging was conducted. Assessment of resting LV function was determined by cine images using a segmented k-space balanced fast-field-echo sequence (Steady-State Free Precession, matrix = 160/256, sense-factor = 2, flip-angle = 60°, slice thickness/gap = 8/2 mm) in continuous short axes covering the whole LV from base to apex as well as 2 and 4 chamber views in anatomically correct heart axes. Image resolution was between 1.4*2.0 and 2.4*2.2 mm^2 depending on the patient's anatomic dimensions and consequent field-of-view adaptation.

After gadolinium injection (Gd = 0.2 mmol/kg bodyweight of gadopentetate dimeglumine, Schering, Germany), three volume stacks of delayed late gadolinium-enhanced images (14–28 slices à 5 mm) covering the whole LV were planned on previous short-, 2 and 4 chamber axes. Image acquisition was achieved between 10 and 15 minutes post Gd with the use of a vector ECG-triggered single breath-hold 3D-gradient-spoiled turbo fast-field-echo sequence with a selective 180° degree pre-pulse. The initial time of inversion (TI in ms) at the beginning of scar imaging was defined using a specific single slice gradient-echo EPI CMR sequence in short axis orientation introduced by Look and Locker (6) and was then dynamically adapted according to the wash-out kinetics of gadolinium (10 ms/5 minutes, starting at TI = 180 and 220 ms depending on the patients heart rate).

CMR data analysis

Data analysis was carried out on a commercially available CMR workstation (Philips Viewforum, Version 3.4, Best, Netherlands). Two observers who were blinded to clinical data conducted image analysis at least 8 weeks after image acquisition.

End-diastolic (EDV, mL) and end-systolic (ESV, mL) volumes with resulting ejection fraction (EF in %) were generated manually using short axes volumetry by determination of end-diastolic and end-systolic heart phases and subsequent delineation of endocardial borders excluding papillary muscles. For evaluation of myocardial mass, borders were also drawn

at the interface between myo- and epicardium on end-diastolic images including papillary muscles.

For quantification of infarct size, we employed a specific scar measurement tool (Philips Viewforum). The area of hyper-enhanced myocardium was traced in each short axis slice and multiplied by the slice thickness and the myocardial density of 1.05 g/ml to obtain the infarct mass on short axes views.

Statistical analysis

Plasma concentrations of cTnT and NT-pro BNP are described as median values with the corresponding interquartile range. Patients with STEMI and NSTEMI were compared using the Mann-Whitney U test. The Pearson partial correlation was used to measure the relationships between NT-pro BNP, cTnT, CMR infarct size and LV- EF, respectively, while controlling the effect of age, gender, body mass index (BMI) and creatinine-clearance. For all analyses, a value of $p < 0.05$ was regarded as statistically significant. All statistical analyses were carried out using the SPSS software package (Version 14, Chicago, IL, USA).

RESULTS

A total of 44 patients with first AMI who had cardiac CMR before discharge were enrolled. Of these, 23 had STEMI, and 21 had NSTEMI. Patients presenting with STEMI received primary PCI immediately. Patients presenting with NSTEMI received early coronary angiography within 24 hours after admission. Primary PCI for STEMI was successful in all 22 patients, and early PCI for NSTEMI was successful in all 20 patients. Including 1 patient with spontaneous reperfusion and 1 patient with non-reperfused AMI in whom PCI was not attempted, a total of 43 patients (97.7%) had reperfused AMI, and only 1 patient had non-reperfused AMI. The median time from onset of symptoms to balloon angioplasty was 6.25 hours for STEMI and 9.9 hours for NSTEMI. The median time delay for the entire cohort was 8.6 hours (IQR 5.1; 23.5).

The baseline characteristics of the entire study population are given in Table 1.

Clinical follow up

Clinical follow-up regarding death, myocardial re-infarction or target vessel revascularization (TVR) via CABG or PCI was performed in 36 of the 44 patients (81.8%). Median follow-up time was 16 months, with a range of 14 days to 29 months. Of the 36 patients, 2 patients died (5.6%), 1 patient had myocardial re-infarction (2.8%), and 7 patients needed TVR (19.4%). There was no significant difference in levels of cTnT, NT-pro BNP, LV-EF nor infarct size or type of infarction (STEMI vs. NSTEMI) between patients with and without any even (Table 3).

CMR results

Absolute and relative infarct sizes were larger in STEMI than in NSTEMI (29.3 g [IQR 16.0; 53.0] vs 8.8 g [IQR 3.3; 16.4], $p < 0.0002$ and 16.4% [IQR 7.7; 27.9]) vs 4.2 [IQR 1.5; 10.0], $p < 0.0002$, respectively).

Table 1. Baseline patient characteristics

Variable	Entire cohort n = 44
Mean Age	58 ± 12
Females	12 (27.3)
BMI	28 ± 4.0
STEMI	23 (52.2)
NSTEMI	21 (47.7)
Symptoms to balloon (min)	516 (307;1411)
CV History	
Previous PCI	3 (6.8)
Previous CABG	2 (4.5)
Heart Failure	1 (2.3)
Hypertension	25 (56.8)
Current smoking	22 (50)
Hypercholesterolemia	25 (56.8)
Diabetes mellitus	7 (15.9)
Creatinine-clearance ($mL^{*}min^{-1}/1.73\ m^2$)	109 (80; 135)
Peak CK (IU/L)	1001 (455; 1785)
TnT_{72-96h}(μg/L)	1.23 (0.52; 2.22)
NT-pro BNP_{72-96h}(pg/mL)	451 (243; 1422)

Data being represented as n (%), Mean ± SD or Median (Q_1; Q_3) as appropriate.
BMI = body mass index, CV = cardiovascular, PCI = percutaneous coronary intervention, CABG = coronary artery bypass grafting, CK = creatine kinase.

Likewise, LV-EF were lower in STEMI (55.6% [IQR 47.5; 62.0]) than in NSTEMI (59.4% [IQR 56.5; 65.3], $p = 0.04$). Patients presenting below the median time delay tended to have a smaller infarct mass and a smaller relative infarct size (13.7 g [IQR 5.9; 26.2] vs 21.3 g [IQR 13.3; 34.1]; $p = 0.16$, and 7.0% [IQR 2.9; 17.9] vs 13.8% [IQR 7.7; 20.4], $p = 0.079$, respectively) than those above the median time delay.

CMR infarct size and LV function by cTnT at 72–96 hours

Median cTnT values were higher in STEMI than in NSTEMI (1.88 [IQR 0.7; 2.57] μg/L vs 0.83 [IQR 0.4; 1.3] μg/L, $p = 0.015$).

Results are displayed in Table 2. There was a strong significant correlation between cTnT and absolute infarct size for all patients (Fig. 3). Correlation between cTnT and infarct size was excellent for STEMI ($r = 0.92$, $p < 0.0001$, Fig. 4) and moderate albeit still significant for NSTEMI ($r = 0.59$, $p = 0.0093$).

cTnT values tended to be lower in patients presenting below median time delay (0.81 μg/L [IQR 0.46; 2.00] vs 1.87 μg/L [IQR 1.05; 2.56], $p = 0.080$) compared to those above the median time delay.

With respect to LV-EF, there was an inverse relationship between cTnT and LV-EF in STEMI ($r = -0.54$, $p = 0.0014$).

CMR infarct size and LV function and NT-pro BNP at 72–96 hours

Median NT-pro BNP values were higher in NSTEMI than in STEMI but not significantly (741 [IQR 282; 1315] vs 385 [IQR 242; 1761]). The results are displayed in Table 2.

Table 2. Correlation coefficients

	cTnT		NT-pro BNP	
Infarct size	Entire cohort (n = 44)		Entire cohort (n = 44)	
Absolute (g)	0.87		0.53	
95% CI	0.76; 0.93		0.26; 0.72	
p value	<0.0001		0.0003	
Relative (%)	0.87		0.45	
95% CI	0.77; 0.93		0.16; 0.67	
p value	<0.0001		0.0029	
	STEMI (n = 23)	NSTEMI (n = 21)	STEMI (n = 23)	NSTEMI (n = 21)
Absolute (g)		0.59	0.79	
95% CI	0.92	0.15; 0.83,	0.52; 0.91,	0.36
p value	0.81; 0.97	0.0093	<0.0001	−0.15; 0.71
Relative (%)	<0.0001	0.76	0.75	0.15
95% CI	0.90	0.43; 0.91	0.45; 0.90	0.21
p value	0.75; 0.96	0.0002	<0.0001	−0.30; 0.63
	<0.0001			0.41
LV performance	Entire cohort (n = 44)		Entire cohort (n = 44)	
	−0.48		−0.70	
EF (%)	−0.69; −0.20		−0.83; −0.50	
	0.0012		<0.0001	
95% CI				
p value				
	STEMI (n = 23)	NSTEMI (n = 21)	STEMI (n = 23)	NSTEMI (n = 21)
EF (%)	−0.54	−0.13	−0.67	−0.85
95% CI	−0.80; −0.11	−0.58; 0.37	−0.86; −0.31	−0.95; −0.63
p value	0.0014	0.60	0.0009	<0.0001

Date given as Pearson partial correlation coefficients with corresponding 95% confidence intervals (CI).
EF = ejection fraction.

There was a good linear correlation between NT-pro BNP and infarct size for STEMI (0.79; [0.52; 0.91], $p < 0.001$) but not in NSTEMI. With respect to LV-EF, there was a moderate inverse correlation between NT-pro BNP and LV ejection fraction both for all patients (Fig. 5) as well as for STEMI (-0.67, $p = 0.0009$) and a good correlation for NSTEMI (-0.85, $p < 0.0001$, Fig. 6).

Comparison between cTnT and NT-pro BNP

We compared cTnT and NT-pro BNP for the evaluation of infarct size and LV ejection fraction. An overview of results of linear regression analysis between cTnT and NT-pro BNP and estimation of infarct size and LV-EF are displayed in Table 2. Pearson partial correlation showed a better relationship for the assessment of absolute and relative infarct size with cTnT than with NT-pro BNP.

Consistently, comparison of ROC curves showed a better performance of cTnT for estimation of infarct size (Fig. 1), while NT-pro BNP was better for assessment of LV-EF (Fig. 2).

Table 3. Outcome data

Event	*Number of events (n = 36)*
Death	2 (5.6)
TVR (PCI or CABG)	7 (19.4)
Re-Infarction	*1* (2.8)
Any event	*10 (27.8)*

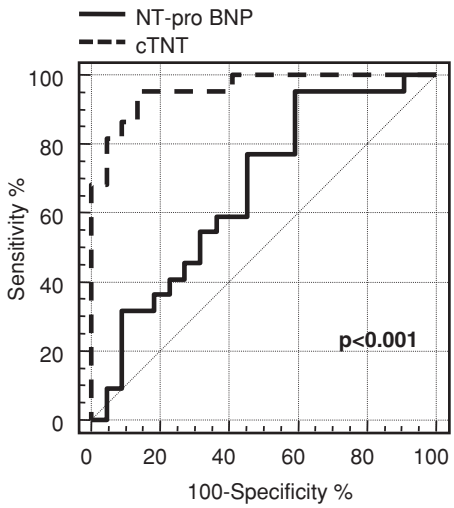
Data being represented as n (%).
TVR = target vessel revascularisation,
PCI = percutaneous coronary intervention,
CABG = coronary artery bypass grafting.

DISCUSSION

The present study shows that a single NT-pro BNP and cTnT value at 72–96 hours after the onset of symptoms are useful for estimation of LV function and infarct size after AMI. Compared with NT-pro BNP, cTnT has a better ability to estimate infarct size while NT-pro BNP proves more useful for estimation of LV function.

Regarding the type of AMI, distinction between STEMI and NSTEMI is important because of potentially different release mechanisms and kinetics of cardiac markers (23, 24). Secondly, patient outcome and future cardiac events are significantly different in both groups.

In addition, NSTEMI comprise a heterogeneous group where patients with small infarcts have different cTnT release time curves than patients with large MI (5). cTnT values correlate excellently with infarct size in STEMI and moderately but still significant in NSTEMI. Furthermore, cTnT provides an acceptable estimate of LV function in STEMI but not in NSTEMI. NT-pro BNP values correlate with infarct size in STEMI only,



cTnT$_{72-96}$ AUC 0.959 (0.851-0.994)

NT-pro BNP$_{72-96}$ AUC 0.667 (0.509-0.802)

ROC Difference 0.291 (0.129-0.453)

Figure 1. Sensitivity and specificity of NT-pro-BNP and cTnT for infarct size. ROC analysis shows a better performance of cTnT at 72–96 hours (AUC 0.959 [0.851-0.994]) for estimation of infarct size compared to NT-pro-BNP (AUC 0.667 [0.509-0.802]). The difference of the ROC curves (delta AUC 0.291 [0.129-0.453]) was statistically significant ($p \leq 0.001$).

whereas assessment of LV-EF is feasible in both STEMI and NSTEMI.

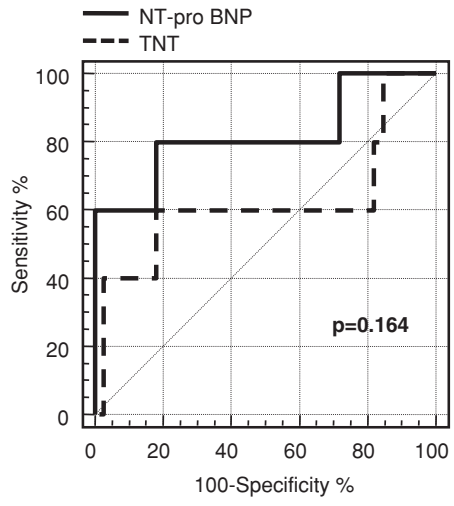
Estimation of infarct size

Several imaging methods competed for infarct size estimation including radionuclide imaging, technetium-99m sestamibi or thallium scintigraphy (1). Unfortunately, limited availability and high costs represent a substantial disadvantage of these techniques.

More recently, LGE-CMR proved useful for visualization of myocardial necrosis. By administering a gadolinium-based chelate as contrast agent that temporarily and specifically accumulates in fibrotic or necrotic myocardial regions, LGE-CMR allows indirect visualization and quantification of the mural extent of irreversible injury (25).

Recently, LGE-CMR follow-up scans have demonstrated some reduction in size of the acutely determined hyperenhancement area over the first few days, mostly due to reduction of the acute oedema as well as partial volume effects (26). In our study, LGE-CMR was performed after a median of only 4 days after admission. Therefore, we cannot exclude some overestimation of infarct size.

In clinical practice, the measurement of cardiac constituents, such as cardiac enzymes and proteins, is frequently used as a rough estimate of the extent of myocardial damage (27, 28).



cTnT$_{72-96}$ AUC 0.621 (0.462-0.762)

NT-pro BNP$_{72-96}$ AUC 0.821 (0.675-0.919)

ROC Difference 0.200 (-0.082-0.482)

Figure 2. Sensitivity and specificity of NT-pro-BNP and cTnT for LV-EF. ROC analysis depicts a better performance of NT-pro-BNP (AUC 0.821 [0.675-0.919]) for assessment of LV-EF compared to cTnT (AUC 0.621 [0.462–0.762]). This difference failed statistical significance (delta AUC 0.200 [−0.082–0.482], $p = 0.163$).

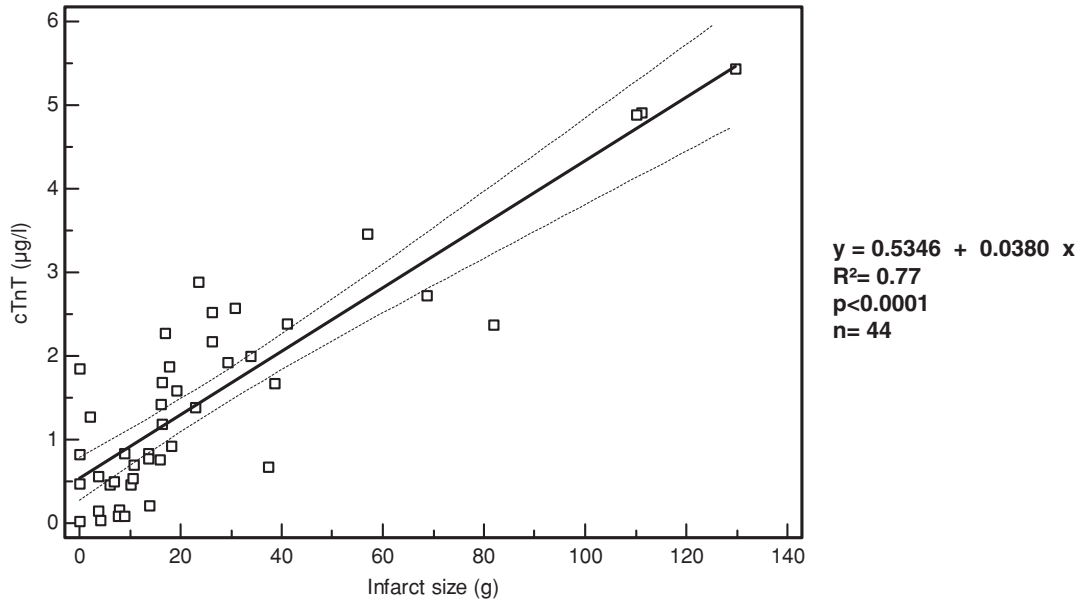


Figure 3. Scatter diagram and regression line for cTnT and infarct size shows a strong correlation between cTnT and infarct size for any type of infarction.

The most important shortcoming in the estimation of infarct size with the cytoplasmatic enzymes such as CK or CKMB and lactate (LDH) or hydroxybutyrate dehydrogenase (HBDH) is the need for serial measurements in order to identify peak or cumulative serum concentrations. Furthermore, cytoplasmatic enzymes show a considerable susceptibility to reperfusion and in addition lack cardiospecificity (29).

In contrast, cTnT is a cardiac-specific protein that is compartmented in the contractile apparatus. Except for the small cytosolic fraction, the release after AMI is prolonged and not affected by reperfusion of the infarct zone (29). An accumulating number of studies have consistently confirmed the usefulness of cTnT or cTnI for estimation of infarct size (30–33). Results from animal studies and clinical trials have demonstrated that even a single cTnT measured 72 to 96 hours after onset of symptoms is useful and as effective as multiple measurements for estimation of infarct size (19–21). In accordance, Licka et al found an excellent correlation of cTnT at 72 hours after hospital admission

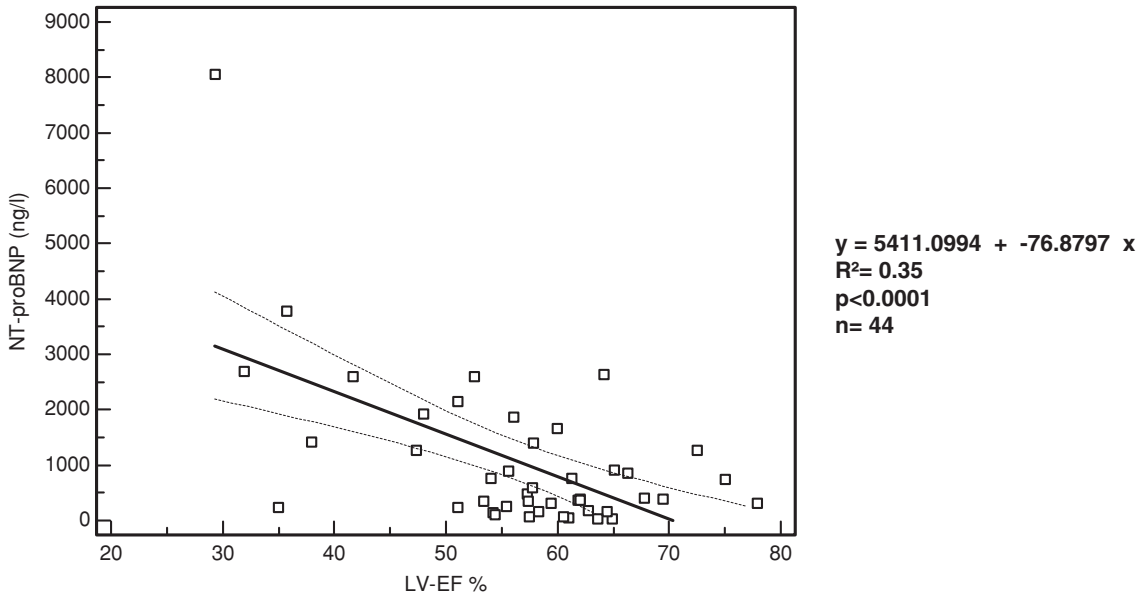


Figure 4. Scatter diagram and regression line for NT-pro BNP and LV-EF shows a good correlation between NT-pro BNP and LV-EF for any type of infarction.

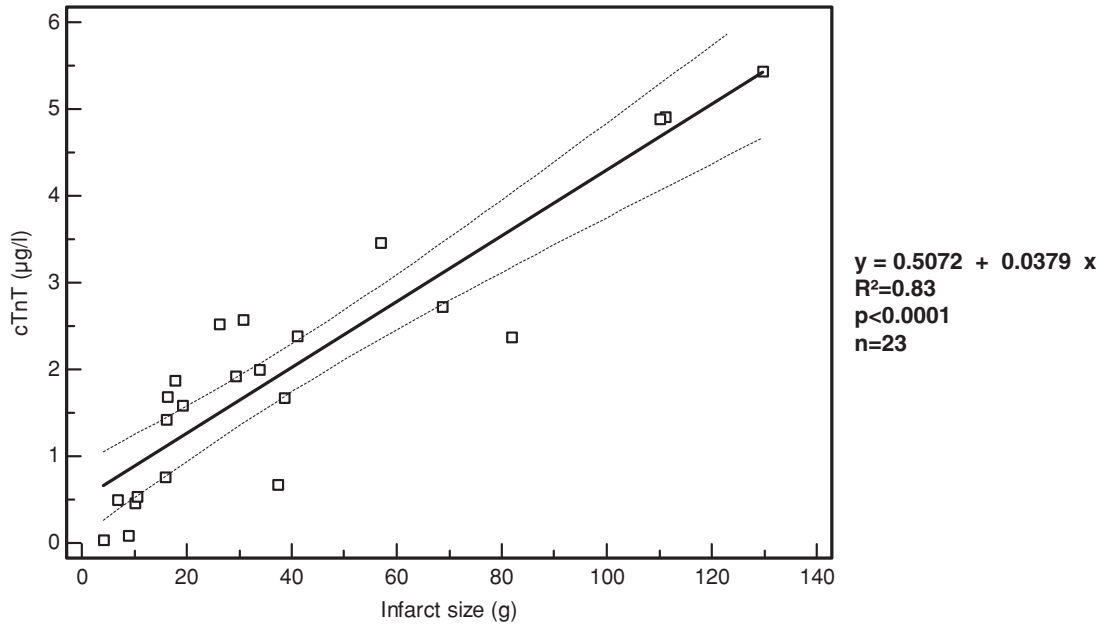


Figure 5. Scatter diagram and regression line for cTnT and infarct size shows an excellent correlation between cTnT and infarct size in STEMI.

and infarct size as measured with thallium scintigraphy (21). Our study found an excellent correlation between the extent of delayed hyperenhancement and cTnT at 72–96 hours. However, correlation was stronger in STEMI and weaker but still significant in NSTEMI.

Several reasons could explain why the correlation between cTnT and LGE-CMR measured infarct sizes was less optimal in NSTEMI patients. Firstly, infarct sizes for NSTEMI patients were significantly smaller and could, therefore, be below the LGE-CMR detection threshold. Secondly, due to relatively low LGE-CMR image resolution, smaller infarcts could also be missed or overlooked due to partial volume effect. Thirdly, small-sized bright subendocardial infarcts are sometimes difficult to distinguish from the likewise bright ventricular blood pool. Also, smaller infarcts potentially have different contrast agent wash-in and wash-out kinetics when compared to larger infarcts with edema and more pronounced microvascular obstruction.

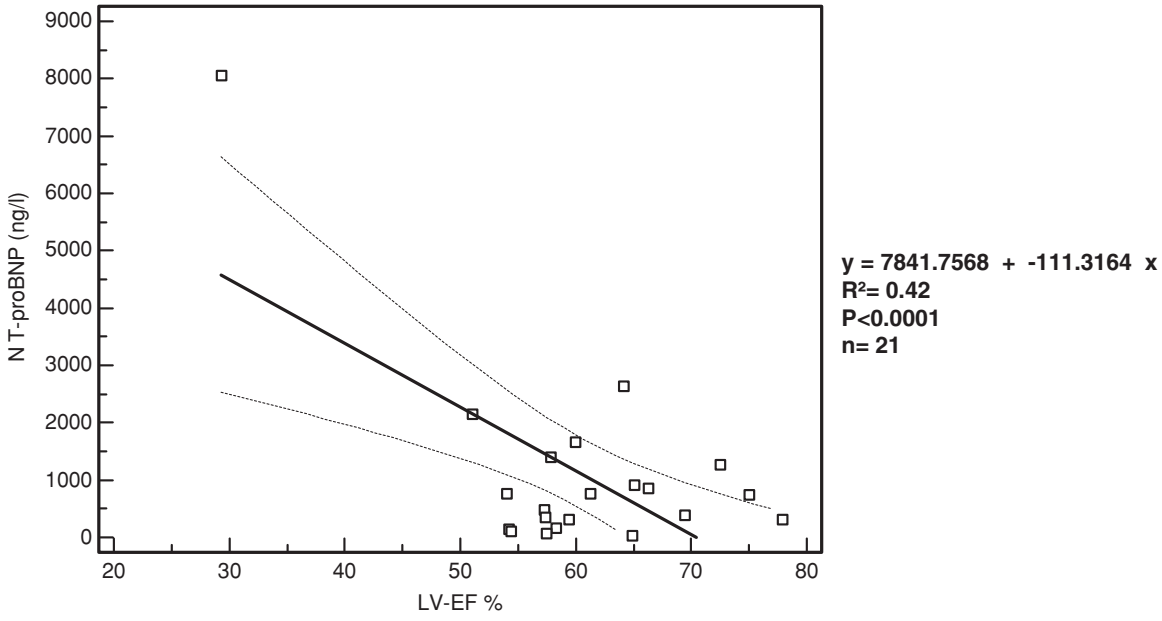


Figure 6. Scatter diagram and regression line for NT-pro BNP and LV-EF shows a good correlation between NT-pro BNP and LV-EF in NSTEMI.

In our study, the association between NT-pro BNP and infarct size was weaker than with cTnT. Given that NT-pro BNP increases in response to systolic LV dysfunction resulting from myocardial ischemia, it is attractive to speculate that the magnitude of NT-pro BNP may be influenced by the extent of myocardial ischemic territory rather than by the extent of the final infarct size (23). Furthermore, today there is no standardized and validated recommendation on the timing of BNP measurement. Thus, missing the appropriate time point could account for the inferior correlation between NT-pro BNP values and infarct size.

Estimation of LV function

Recent interest has focused on natriuretic peptides for estimation of LV function and prognosis in patients with an acute coronary syndrome (7–9).

In our study, a single NT-pro BNP value measured 72–96 hours after the onset of symptoms was inversely correlated to LV function in STEMI and NSTEMI. Our single measurement protocol is supported by the findings from serial measurements showing a biphasic pattern of NT-pro BNP release after acute anterior MI with peak concentrations within 48 hours, a subsequent decline and a secondary rise at around day 5 (13). Compared to earlier or later measurements, NT-pro BNP measured at 72 to 120 hours was the best predictor for LV dysfunction and death at 6 weeks. Likewise, Richards et al found that plasma levels of BNP and NT-pro BNP measured 2 to 4 days after AMI predicted LV-EF and 2 year survival independently (12). In line with previous reports (23, 24), NT-pro BNP values in our study were higher in patients with NSTEMI than in patients with STEMI, and NT-pro BNP correlated better with LV-EF in NSTEMI than in STEMI. Conversely, NT-pro BNP showed significant relationship with infarct size only in STEMI. Although the exact reason is still illusive, it is tempting to speculate that higher levels of NT-pro BNP in NSTEMI are the consequence of the total ischemic burden arising from jeopardized myocardium while the magnitude of NT-pro BNP elevation in STEMI is directly related to the extent of irreversible myocardial necrosis (34). In addition, repeated bouts of myocardial ischemia before the index event in NSTEMI may account for higher values of NT-pro BNP alluding to the different patho-mechanism of infarction between STEMI and NSTEMI.

Limitations

Firstly, the prediction of infarct size with cTnT in patients with NSTEMI is less accurate prohibiting its utilization for clinical practice or scientific purpose at the moment.

The use of NT-pro BNP for measurements of infarct size is even less well settled and correlations were found to be inferior compared to cTnT.

It may be speculated that a fixed time point for blood sampling at 72–96 hours does not adequately account for differences with respect to time release kinetics between STEMI and NSTEMI. We used this time point because there is some evidence that sampling between 73 and 120 hours is an independent prognosticator of LV motion index and prognosis at six weeks (13).

Measuring the integrated area under the cTnT curve or a measurement at a different time point probably would have improved estimation of infarct sizing of NSTEMI. In addition, LGE-CMR image resolution and other technical issues may interfere more significantly in smaller infarcts.

Secondly, our study did not specifically address whether cTnT measurement at 72–96 hours is completely independent of reperfusion status. However, based on previous findings, it is tempting to speculate that late cTnT sampling is independent of early reperfusion success (24).

Therefore, we did not exclude the one patient with non-reperfused AMI from our analysis.

CONCLUSIONS

CMR is a novel non-invasive imaging technique and is referred to as the reference standard for assessment of myocardial function and morphology. LGE-CMR enables visualisation of less than 1 g of infarcted myocardial tissue in AMI patients (4). Because of its high diagnostic accuracy to detect even small myocardial infarcts, we correlated CMR visualized myocardial necrosis with serum markers of myocardial cell degradation (TNT) and function (NT-pro BNP).

Measurement of NT-pro BNP and cTnT on a single occasion at 72–96 hours after AMI is easy and inexpensive and provides valuable information on LV function and infarct size. Our results demonstrate that NT-pro BNP is more useful for estimation of LV function than cTnT, whereas cTnT is more useful for estimation of infarct size. Thus, a combination of both markers could provide complementary information after AMI.

ABBREVIATIONS

AMI	acute myocardial infarction
cTnT	cardiac troponin T
EDV	End-diastolic volume
EF	Ejection fraction
ESV	End –systolic volume
IQR	Inter- quartile range
LV	left ventricular
LV-EF	LV function
NSTEMI	Non-ST-segment elevation myocardial infarction
NT-pro BNP	N-terminal brain-type natriuretic-peptide
PCI	Percutaneous intervention
STEMI	ST- segment elevation myocardial infarction

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