BRIEF REPORT

Usefulness of Troponin I for Predicting Systolic Dysfunction in Acute Coronary Syndromes. Results of a Prospective and Quantitative Study

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The relationship between troponin I and systolic function (quantitative contrast ventriculography) was evaluated in 137 consecutive patients with a first acute coronary syndrome (60 with and 77 without ST elevation). In general, a larger troponin I peak value was related with a more depressed ejection fraction and poorer regional systolic function ($p < 0.0001$). Nevertheless, this correlation was weaker than expected, especially in those cases without ST-segment elevation, suggesting that other factors apart from systolic dysfunction must be taken into account in order to explain the worse prognosis of those patients with increased serum levels of this marker of myocardial damage.

Key words: *Troponin. Unstable angina. Infarction. Systole. Prognosis.*

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Utilidad de la troponina I para predecir la disfunción sistólica en los síndromes coronarios agudos. Resultados de un estudio prospectivo y cuantitativo

Se evaluó la relación existente entre la troponina I y la función sistólica (ventriculografía cuantitativa de contraste) en 137 pacientes consecutivos con su primer síndrome coronario agudo (60 con ascenso y 77 sin elevación del segmento ST). Globalmente, un mayor pico de troponina I se relacionó con una fracción de eyección y una función regional más deprimidas ($p < 0,0001$). Sin embargo, esta correlación fue más débil de lo esperado, especialmente en aquellos casos sin ascenso del segmento ST, lo que sugiere que otros factores, aparte de la mayor disfunción sistólica, deben contribuir en la explicación del peor pronóstico de los pacientes con elevación de este marcador de daño miocárdico.

Palabras clave: *Troponina. Angina inestable. Infarto. Sístole. Pronóstico.*

INTRODUCTION

Ventricular function is the best predictor of death after an acute coronary syndrome.[1] Markers of myocardial damage provide information on systolic function,[2] as well as the diagnosis[3] and the prognosis.[3-7] In acute coronary syndromes with elevation of the ST segment, troponin values show an inverse correlation with left ventricular ejection fraction.[2] In cases without ST segment elevation, this relationship has not been analyzed in depth, although troponin I, together with other factors,[3-8] has been shown to provide important prognostic information. The present study prospectively analyzes the relationship between maximum troponin I values and systolic function, determined by quantitative contrast ventriculography, in a consecutive group of patients presenting for the first time with an acute coronary syndrome.

PATIENTS AND METHOD

Study group

The study group consisted of 137 consecutive patients hospitalized for a first acute coronary syndrome, who underwent cardiac catheterization before hospital discharge. Among 195 catheterized patients, 58 cases were excluded because ventriculography or echocardiography suggested previous disease. The study included 60 patients (44%) with ST segment elevation (>1 mm in two or more contiguous leads that did not resolve with nitrates) and chest pain >30 min, and 67 (56%) patients without ST

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ABBREVIATIONS

AUC: area under the ROC curve.
SD: standard deviation.
EXT: extent of regional dysfunction.
EF: ejection fraction.
95% CI: 95% confidence interval.
RR: relative risk.

TABLE 1. **Correlation between systolic function and maximum troponin I**

	EXT	EF
Total patients (n=137)		
Spearman coefficient	0.48 (*P*<.0001)	−0.41 (*P*<.0001)
No ST segment elevation (n=77)		
Spearman coefficient	0.23 (*P*<.05)	−0.11 (*P*=.3)
ST segment elevation (n=60)		
Spearman coefficient	0.36 (*P*=.004)	−0.40 (*P*=.002)

EXT indicates extent of regional dysfunction; EF, ejection fraction

segment elevation who had chest pain suggestive of acute coronary syndrome to the cardiologist on duty, and at least one of the following: ST depression >1 mm; troponin I peak >1 ng/mL or positive ergometry within the first 24 h, performed in the chest pain unit. Troponin I was determined by immunometric assay (Immulite turbo-troponin I; DPC; Los Angeles, USA) at admission and at 8, 12, 18 and 24 h after the onset of symptoms (until detection of the maximum value). The cut-off value used for the diagnosis of infarction (1 ng/mL) was the recommended value for our laboratory, in which the method has a coefficient of variation below 10%.

Contrast ventriculography in the right anterior oblique projection was carried out at a median of 4 days (range, 2-5 days). A digital system (Integris HM 3000; Philips, Holland) was used to analyze left ventricular function. Ejection fraction was calculated by the area-longitude method and regional ventricular function was determined by the centerline method.[10] The extent of regional dysfunction was defined as the number of hyperkinetic chords: less than -1 SD with respect to the normal population. In keeping with previous data,[11] ejection fraction <50% and extent of regional dysfunction >6 chords were considered significant.

Statistical analysis

Continuous variables were expressed as mean±SD and non-parametric variables as median and interquartile range. Categorical variables were expressed as percentage and were compared with the χ^2 test; relative risks and 95% confidence intervals (CI) were calculated. The relationship between systolic function parameters and maximum troponin value was analyzed by the Spearman correlation coefficient. The area under the ROC curve was used to quantify the precision of troponin I for detecting the presence of systolic dysfunction. In all cases a $P<.05$ was considered significant. Statistical analyses were performed with the SPSS 9.0 software package (Chicago, Illinois).

RESULTS

Among the total study group, mean age was 60±12 years and 78% were men. The median and interquartile range of troponin I values was 6.6 (0-58.7) ng/mL. Ejection fraction was 67%±16% and the extent of regional dysfunction was 8 (0-58.7) chords. Regional dysfunction >6 chords was observed in 78 cases (57%) and ejection fraction <50% in 20 cases (15%).

In the overall series, the highest troponin values were related with poorer ejection fraction and greater regional dysfunction (*P*<.0001) (Table 1). Maximum troponin I value was accurate for the detection of cases

TABLE 2. **Predictive values, sensitivity and specificity of troponin I for detecting regional dysfunction (EXT>6 chords) and overall dysfunction (EF<50%)**

	Cut-off point (ng/mL)	PPV	NPV	SE	SP	AUC (95% CI)	*P*
Total patients (n=137)							
EXT>6 chords	4	73%	63%	70%	66%	0.73 (0.65-0.82)	<.0001
EF<50%	20	34%	94%	75%	75%	0.86 (0.80-0.92)	<.0001
No ST segment elevation (n=77)							
EXT>6 chords	4	58%	66%	44%	78%	0.62 (0.49-0.75)	.07
EF<50%	10	27%	100%	100%	85%	0.75 (0.63-0.869)	<.0001
ST segment elevation (n=60)							
EXT>6 chords	28	89%	40%	67%	71%	0.72 (0.57-0.87)	.01
EF<50%	88	48%	86%	69%	71%	0.71 (0.55-0.87)	.02

AUC (95% CI) indicates area under the ROC curve with 95% confidence intervals; SP, specificity; EXT, extent of regional dysfunction; EF, ejection fraction; SE, sensitivity; NPV, negative predictive value; PPV, positive predictive value.

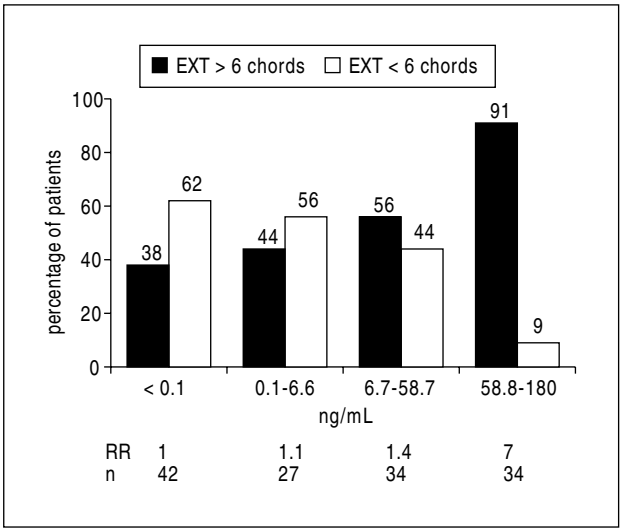

Fig. 1. The study group is divided into quartiles according to peak troponin I values (x-axis). A progressive increase in the percentage of patients (y-axis) with regional systolic dysfunction is observed (black bars: extent of regional dysfunction >6 chords). Differences between the highest and lowest quartile are significant (relative risk with 95% CI, 7 [2.3-21.2]; *P*<.0001).
Ext indicates extent of regional dysfunction; n, number of patients in each quartile; RR, relative risk (with respect to the lowest quartile).

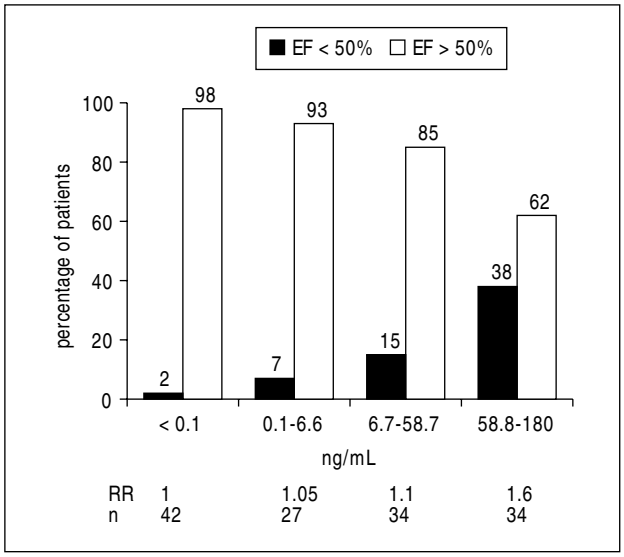

Fig. 2. The study group is divided into quartiles according to peak troponin values I (x-axis). A progressive increase in the percentage of patients (y-axis) with overall systolic dysfunction is observed (black bars: ejection fraction <50%). Differences between the highest and lowest quartile are significant (relative risk with 95% CI, 1.6 [1.2-2.1]; *P*<.0001).
EF indicates ejection fraction; n: number of patients in each quartile; RR, relative risk (with respect to lowest quartile).

with ejection fraction <50% (area under the ROC curve: 0.86 [0.80-0.92]; Table 2). Division of maximum troponin values into quartiles disclosed a gradual increase in the percentage of patients with regional dysfunction, but differences were only significant when the uppermost and lowermost quartiles were compared: relative risk and 95% CI of 7 (2.3-21.2) for regional dysfunction and 1.6 (1.2-2.1) for ejection fraction; *P*<.0001 in both cases (Figures 1 and 2).

Patients without ST segment elevation (n=77) presented a smaller percentage of cases with regional dysfunction >6 chords (42% vs 77%; *P*<.0001) and with ejection fraction <50% (5% vs 28%; *P*<.0001) than patients with ST segment elevation (n=60). Maximum troponin I value was higher in patients with elevated ST segment receiving thrombolytic treatment (n=30) than in those without treatment (n=30): 100 (56-121) vs 15 (4.2-51) ng/mL, respectively; *P*<.0001.

The correlation between troponin I and systolic function was weaker in the patients without ST segment elevation (Table 1). Analysis of ROC curves showed that maximum troponin I value detected both overall and regional systolic dysfunction in the subgroup with ST segment elevation, whereas in those without ST elevation its predictive capacity was low, particularly for regional dysfunction (Table 2).

DISCUSSION

As has been shown previously,[2] troponin I peak values provided information on systolic function. In patients with ST segment elevation and in whom ejection fraction analysis was delayed, Rao et al[2] observed that troponin was a good indicator of depressed ejection fraction. The relationship between peak troponin and systolic function in patients without ST segment elevation, however, has received little attention in the literature.

The relationship between troponin I and systolic function in our series was closer in the patients with elevated ST segment. This is probably attributable to the higher prevalence of significant dysfunction in these cases, whereas in the patients with a first acute coronary syndrome and no ST segment elevation, the percentage of cases with systolic dysfunction was low. The best cut-off points for detecting systolic dysfunction were higher in cases of elevated ST segment (Table 2), because of more pronounced myocardial damage and higher release of markers, due in part to the «washout» phenomenon occurring in patients receiving thrombolytic treatment.

Division of troponin I values into quartiles resulted in a progressive increase in the percentage of cases with systolic dysfunction, with significant differences only in the comparison between the uppermost and lowermost quartiles. Troponin I and systolic function, analyzed as continuous variables, presented a significant, though weak, correlation. These findings suggest that the probability of macroscopically relevant myocardial damage (detectable by quantitative ventriculography)

being present would only increase in cases with very high troponin I values (upper quartiles) and that the relationship between these factors is not linear. In patients with minimum troponin I elevations, however, particularly those without ST elevation, the high prognostic value of this parameter[3-8,12] does not seem to depend on the myocardial damage sustained; identification of patients with true unstable ischemic heart disease[3] or its relation with more unstable or thrombotic lesions[9] could explain the usefulness of troponin I in the situation described.

Finally, in acute coronary syndromes, not all the prognostic information should focus on systolic function or markers of myocardial damage. Clinical variables (age, diabetes, heart failure, etc.), electrocardiographic evidence (depressed ST segment), other serologic markers (C-reactive protein, fibrinogen, etc.) should be taken into account for a correct stratification of risk.[3-8]

CONCLUSIONS

After a first acute coronary syndrome, elevated troponin I values were useful for identifying patients with depressed systolic function. The correlation between these variables was weaker than expected, however, particularly in patients without ST segment elevation, suggesting that the prognostic power of troponin I depends on other factors in addition to the myocardial damage sustained.

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