SCIENTIFIC LETTER

Prognostic implications of the blood pressure response to the Valsalva manoeuvre in elderly cardiac patients

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Heart failure is primarily a disorder of the elderly. The prognosis of patients with heart failure is poor; half of them will die within four years.¹ Estimation of life expectancy of an individual patient can contribute to the well-being of the patient. The blood pressure response to the Valsalva manoeuvre is related to pulmonary capillary wedge pressure (PCWP),² which is raised in heart failure and related to mortality.³ In this study, we examined the relationship between the blood pressure response to the Valsalva manoeuvre and mortality in a heterogeneous group of elderly patients with cardiac disease undergoing right-sided cardiac catheterisation.

METHODS

Between March 2000 and April 2002, consecutive elderly patients (n = 104) scheduled to undergo right-sided catheterisation were initially enrolled. The data of 11 patients were discarded for various reasons, leaving 93 patients (38 women), aged 71 (SD 5) years, eligible for analysis. The study was approved by the Ethics Committee for Research on Human Subjects of the University Medical Center Nijmegen.

PCWP was determined with a Swan–Ganz catheter (Baxter, Irvine, California, USA). Non-invasive continuous blood pressure and heart rate were measured on a finger with a Finapres device (Model 2300; Ohmeda, Englewood, Colorado, USA).

Immediately after measurement of PCWP, the Valsalva manoeuvre was performed with the patient in the supine position, preferably three times but at least once, depending on the patient's ability. An expiratory pressure of at least 20 mm Hg was required for 12 s. A tiny hole in the tube ensured that the pressure was generated in the thorax and not in the mouth.

A normal blood pressure response to the Valsalva manoeuvre consists of four typical phases. An abnormal blood pressure response is characterised by absence of decrease of blood pressure.² From the blood pressure response, the pulse pressure ratio (PPR) was calculated as the ratio of the mean of the three lowest successive pulse pressures in phase 2 and the three highest pulse pressures in phase 1.

Primary outcome was death from all causes. Kaplan–Meier survival curves were compared by the log rank test. Multivariable Cox regression was used to determine independent predictors of mortality. Survival was assessed at four months after inclusion of the last patient. Values are expressed as mean (SD), unless stated otherwise. The criterion for significant difference was set at $\alpha = 0.05$. For continuous data, differences were assessed with paired samples t tests, or by one-way analysis of variance when appropriate. Data were statistically analysed with SPSS V.10.0 (SPSS Inc, Chicago, Illinois, USA).

RESULTS

Median duration of follow up was 396 days (range 1–815); 20 patients died, seven of heart failure, nine of cardiac

Figure 1 Kaplan–Meier survival for tertiles of the pulse pressure ratio (PPR), with 31 patients each tertile. Log rank for survival pooled over all tertiles.

complications after cardiac surgery and four of non-cardiac complications after cardiac surgery. No patients were lost to follow up.

Figure 1 shows that survival differed significantly between tertiles of PPR. PCWP was higher in the third tertile than in the first and second tertiles. PPR was related to mortality (hazard ratio (HR) per step of 0.1 of 1.43, 95% confidence interval (CI) 1.12 to 1.84, $p = 0.005$). Multivariable analysis identified PPR as an independent predictor of mortality (HR 1.52, 95% CI 1.12 to 2.07, $p = 0.008$) in a model with age, sex, LVEF, heart failure at admission, myocardial infarction, heart rate, presence of pulmonary rales and New York Heart Association class.

In a model with (invasive) PCWP and (non-invasive) PPR, PCWP was a univariate predictor of mortality (HR per mm Hg of 1.07, 95% CI 1.02 to 1.13, $p = 0.008$; HR for PPR of 1.32, 95% CI 0.99 to 1.78, $p = 0.061$).

For patients not undergoing cardiac surgery (n = 48), PPR was a univariate predictor of mortality (HR 2.06, 95% CI 1.18 to 3.59, $p = 0.011$). For patients who underwent cardiac surgery (n = 45), PPR was not a univariate predictor of mortality (HR 1.24, 95% CI 0.93 to 1.66, $p = 0.14$).

DISCUSSION

The main finding in this study is that the PPR of the Valsalva manoeuvre is related to the risk of mortality in a heterogeneous group of elderly patients with cardiac disease undergoing right-sided cardiac catheterisation. The PPR may therefore be of use in the assessment of a patient's life expectancy.

The absence of a decrease in blood pressure during the Valsalva manoeuvre is considered to be caused by a rise of central venous and pulmonary venous pressure, enabling sustained filling of the heart, despite the increased intrathoracic pressure.² The decrease in blood pressure also depends on

Abbreviations: CI, confidence interval; HR, hazard ratio; PCWP, pulmonary capillary wedge pressure; PPR, pulse pressure ratio

the slope of the left ventricular function curve (stroke work or pulse pressure plotted against filling pressure), which depends on the severity of heart disease.² Furthermore, the absence of a decrease in blood pressure may be caused by increased sympathetic activity and reduced vagal activity, which is seen in heart failure and which is associated with increased mortality.³

Among patients not undergoing surgery, all patients who died, died of heart failure and PPR was strongly related to mortality. The predictive value of PPR was lower for those patients who died after cardiac surgery. Apparently, other factors than those reflected by the Valsalva manoeuvre may have caused death.

Notably, the expiratory pressure during the Valsalva manoeuvre differed between patients, which could have influenced our findings. Low expiratory effort may be caused by general weakness or poor compliance, meaning that if expiratory pressure is low, the decrease of pulse pressure is small, regardless of cardiac filling pressures.

In conclusion, the PPR of the Valsalva manoeuvre was related to the risk of death in a heterogeneous group of elderly patients with cardiac disease undergoing right-sided cardiac catheterisation. The PPR may therefore be a non-invasive prognostic marker in addition to established invasive and non-invasive prognostic variables. These hypothesis-generating findings fuel interest in large prospective studies on the prognostic implications of the Valsalva manoeuvre.

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IMAGES IN CARDIOLOGY

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Massive tear of the mitral valve after percutaneous mitral commissurotomy by live 3D transthoracic echocardiography

A 45-year-old woman was referred to our cardiology department for percutaneous mitral commissurotomy. Mitral stenosis was known for several years and the patient progressively developed symptoms (New York Heart Association functional class III). Her mitral valve was slightly calcified; mitral valve area was 1 cm² and mean transmitral gradient 8 mm Hg. There was a mild associated regurgitation. Systolic artery pulmonary pressure was 38 mm Hg. After the first balloon inflation, she developed a severe mitral regurgitation due to a massive tear located in the mid part of anterior leaflet. The tear was suspected by two-dimensional echocardiography but clearly shown by live three-dimensional echocardiography and confirmed during surgery performed two days later.

Numerous reports have demonstrated the safety and efficacy of percutaneous mitral commissurotomy and this technique has virtually replaced surgical commissurotomy. However, severe mitral regurgitation remains a worrying complication and can occur in 2–10% of patients. Live three-dimensional echocardiography is a relatively new echocardiographic modality, which looks very promising for the assessment of mitral valve anatomy.

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Apical view of the mitral valve (three-dimensional echocardiography). Note the tear in mid part of the anterior leaflet (arrow).