Validation of Doppler Flow Guidewire for Peak Aortic Flow Measurement in Order to Establish Its Sensitivity for Recognition of Cardiac Assistance in Demand Dynamic Cardiomyoplasty

Gianluca Rigatelli, Mario Barbiero(1), Giorgio Docali(1), Mario Zanchetta(2), Luigi Pedoni(2), Adriano Baratto(2), Pietro Maiolino(2), Giorgio Rigatelli(1), Ugo Carraro(3), and Sergio Dalla Volta

Department of Cardiology, Padua School of Medicine, Padua, (1) Division of Cardiology, Cardiomyoplasty Project, Legnago General Hospital, Verona, (2) Division of Cardiology, Cittadella General Hospital, Padua, and (3) Department of Biomedical Sciences, University of Padua, Padua, Italy

Abstract

INTRODUCTION: there are no certain data regarding the real cardiac assistance of cardiomyoplasty. We tested the use of doppler flow wire for measurement of aortic flow velocity (directly related with cardiac output) in order to demonstrate that this method is able to measure systolic assistance during stimulated beats in cardiomyoplasty.

METHOD: the technique has been tested in five coronaropathic patients (M/F = 4/1; age = 61±7.1; atrial fibrillation / sinus rhythm = 1/4; VTD = 76.6±8.26 ml/mq; EF = 67.4±8.56). The measures were performed during a normal cardiac left catheterization for coronarography using a FlexTM Doppler flow wire of .018 inch through a 4F introducer femoral arterial access. Stimulated beats were obtained with a right ventricle stimulator catheter through a femoral venous access.

RESULTS: fourth series of measures, composed by 10 normal beats and 1 stimulated beat, were recorded; we measured the maximal peak velocity of beat n°9 (normal) and beat n°1 (post-stimulated beat) of the subsequent series. The values respectively for normal beats and for post-stimulated beats were: - first series: 50.4±13.5 and 63.4±17.5 cm/s (P = 0.0091); - second series: 65.4±15.4 and 75.2±14.4 cm/s (P = 0.0044); - third series: 49.8±8.43 and 62.4±17.7 cm/s (P = 0.0249); - fourth series: 56.8±15.4 and 63.4±13.3 cm/s (P = 0.0024). No complications were observed after the procedure.

DISCUSSION: Statistical analysis showed a significant increasing in peak flow velocity after the stimulated beats. Therefore the technique is safe and effective and may be sensitive enough to detect a similar phenomenon related to a real systolic improvement owing to latissimus dorsi graft contraction. In the first two demand dynamic cardiomyoplasty operated patients tested with this method, it has been showed an increase of 10% in aortic flow velocity between stimulated and no-stimulated beats.

Key words: intravascular ultrasound, heart failure.

Nowadays there are no certain data about the real cardiac assistance that dynamic cardiomyoplasty (DCMP) and its recent development, demand dynamic cardiomyoplasty (DDCMP), could offer. After the initial enthusiasm due to the early experience in which the cardiomyoplasty seemed to be a feasible alternative to heart transplant [4, 6, 9, 10, 16], this technique lost part of its consideration not only for a discreet mortality and morbidity [13, 14, 18] but also for the poor proofs of a true cardiac assistance and the absence of direct evidence of systolic enhancement during latissimus dorsi contraction in human. Actually, for the lack of organs in Europe, the DCMP is subject of further investigations. Following this increase of interest, we tried to found a simple, repeatable and tangible method to reveal and measure every real cardiac assistance made by latissimus dorsi in cardiomyoplasty operated patients. The main reasons of the difficult measurement of an even-

Basic Appl Myol 10 (3): 127-130, 2000
Flow wire for cardiomyoplasty evaluation

In these last 10 years, dynamic cardiomyoplasty underwent to many investigations: firstly, in order to establish its feasibility in alternative to heart transplant, secondly to prove its effects on cardiac function. This feasibility in alternative to heart transplant was rejected by great part of the Authors and the technique has actually few indications. Nowadays there is a new interest in the technique, due to the cost of the mechanic assistance and the lack of organs in Europe: the vascular delay [1,12] and the demand stimulation protocol [2,7] are giving to cardiomyoplasty new dignity.

About the effects of DCMP, two main hypothesis were made to explain the improvement of symptoms in patients who respond to DCMP: an enhanced systolic contraction and a limited heart dilatation [3,15,17,19,20]. If many Authors agree with the second hypothesis that may explain the improvement in NIH class in some patients, as for the first one there is more perplexity.

In fact, measurements in dynamic cardiomyoplasty, as ejection fraction [6,21], P/V loops [5,22], stroke volume and peak oxygen consumption [25] were recorded before and after the intervention or during periods with myostimulator turned on and off: these periods were relatively long and variable in time and they are dependent by many physical factors and environment. There are no data until now in DDCMP, about beat to beat analysis of changes in cardiac function during stimulated and non stimulated beat: the analysis about this variant of cardiomyoplasty could be more independent and so more accepted by the Cardiologist community.

Results

Fourth series of measures, composed by 10 normal beats and 1 stimulated beat, were recorded: we measured the maximal peak velocity of beat n° 9 (normal) and beat n° 1 (post-stimulated beat) of the subsequent series. The values respectively for normal beats and for post-stimulated beats were: - first series: 50.4±13.5 and 63.4±17.5 cm/s (P = 0.0091); - second series: 65.4±15.4 and 75.2±14.4 cm/s (P = 0.0044); - third series: 49.8±8.43 and 62.4±17.7 cm/s (P = 0.0249); - fourth series: 56.8±15.4 and 63.4±13.3 cm/s (P = 0.0024). The fluoroscopy time was in all patients < 1 minute. No complications were observed during and after the procedure.

Discussion

In fact, measurements in dynamic cardiomyoplasty, as ejection fraction [6,21], P/V loops [5,22], stroke volume and peak oxygen consumption [25] were recorded before and after the intervention or during periods with myostimulator turned on and off: these periods were relatively long and variable in time and they are dependent by many physical factors and environment. There are no data until now in DDCMP, about beat to beat analysis of changes in cardiac function during stimulated and non stimulated beat: the analysis about this variant of cardiomyoplasty could be more independent and so more accepted by the Cardiologist community.
Flow wire for cardiomyoplasty evaluation

Measurement of aortic peak flow velocity by Doppler echocardiography could be the most direct method: it was proposed and it is really used to measure cardiac output in normal patients. Unfortunately in cardiomyoplasty operated patients, the instability of ascending aorta during the latissimus dorsi contraction makes difficult and not sensitive this measure.

Interventional Cardiology helps us giving an intravascular method for recording aortic peak flow velocity, the Doppler Flow Guide Wire. This intravascular guide wire usually used for the calculation of the coronary reserve and the evaluation of the coronary stenosis, has been validated in vitro and in vivo. The qualitative registration of phasic flow is possible and the relative changes can be determined with sufficient accuracy by intravascular Doppler wires. The limit is the unreliability of the measurement of absolute flow volume due to interindividual differences of the catheter within the vessels [11, 23]. We believe that this fact has not great importance, because our aim is to measure a difference between the aortic peak velocity of non stimulated and stimulated beat, rather than its absolute value.

As matter of the fact, aortic peak flow velocity is directly correlated with the cardiac output as showed by the simplified equation Q = VA, where Q is the volume flow rate, V is the flow velocity and A is the cross sectional area of a circular pipe [26]. So any change in flow velocity causes a modification of flow volume, independently by the absolute value.

Our data showed that the measure of Doppler aortic flow velocity using an intravascular wire is safe and effective. The increase of flow velocity after the extra-stimulated beat is measurable (figure 1) and the recording beat to beat is effective and sensitive enough, as proved by statistical analysis.

An eventual cardiac assistance due to DDCMP could be measurable by this method. We can anticipate that in the first two DDCMP patients tested with this method, it has been showed an increase of 10% in aortic flow velocity between stimulated and non stimulated beats. If this fact has been validated in vitro and in vivo, the increase of flow velocity after the extrastimulated beat, rather than its absolute value, might give new interest in the correlation between stimulated and non stimulated beats. Further investigation will continue, it may give new interest light to DDCMP.

Address correspondence to:
Dr. G. Rigatelli, Department of Cardiology, Padua School of Medicine, Via T. Speri, 18, 37040 Legnago, Italy, Email jackyheart@katamail.com

References
Flow wire for cardiomyoplasty evaluation


