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ORIGINAL ARTICLE

Procalcitonin Dynamics After Long-Term Ventricular Assist Device Implantation

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Background Infectious complications (IC) are one of the main causes of worsening prognosis after long-term ventricular assist device (LVAD) implantation. Procalcitonin (PCT) is widely used for diagnosis of a bacterial infection. The objective of this study was to assess PCT dynamics after LVAD surgery and their relationship to the infectious complications.

Methods A total of 25 consecutive patients indicated for LVAD implantation as a bridge to heart transplant were included. Procalcitonin levels were prospectively assessed before surgery and during the postoperative period (day 1, 2, 14 and 30). Values were compared according to the presence of IC.

Results Procalcitonin levels were low before surgery, raised significantly within 1st and 2nd day after operation and decreased in the 14th and 30th days back to the baseline. There was no significant difference in PCT values between patients with or without IC as well as with or without right ventricle assist device (RVAD). Acute renal failure (ARF) increased PCT significantly only 14 days after LVAD implantation. In patients with ARF and/or RVAD we observed significantly higher PCT values in the 2nd, 14th and 30th day after operation. In subjects with IC and/or ARF and/or RVAD we also observed significantly elevated PCT concentrations 2 and 14 days after surgery.

Conclusions Our data show that the ability of PCT to detect IC in patients after LVAD implantation is limited and its concentrations more likely correlate with postoperative complications in general.

Keywords Mechanical circulatory support • Procalcitonin • Ventricular assist device • Infection • Systemic inflammatory response syndrome • Heart failure

Background

Long-term left ventricular assist device (LVAD) implantation is — over 14 years after REMATCH trial [1] — common treatment modality in patients with end-stage heart failure as a bridge to heart transplant or destination therapy. During past years, progressive improvement has been made in device technology including particularly smaller implantable continuous flow pumps instead of paracorporeal pulsatile devices. Despite all these advances infectious complications remain one of the main causes worsening both short-term and long-term prognosis [2]. In our retrospective cohort of 145 patients, who underwent LVAD implantation between 2003 and 2012, mortality rate during one-year follow-up was 26% (37/145). With a causal link to the 40% of all deaths, infection was the most life-threatening complication in postoperative period [3]. This fact also represents economic issues with rising hospitalisation costs [4].

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Nevertheless, early and accurate diagnosis of infectious complications is challenging due to serious preoperative status with organ dysfunction and systemic inflammatory response syndrome (SIRS) after surgery caused by cardiopulmonary bypass (CPB) [5]. Procalcitonin (PCT) is widely used for the diagnosis of bacterial infection and has proved its superiority over other inflammatory markers such as C-reactive protein [6]. There are several papers confirming the usefulness of PCT in differential diagnosis between infectious and non-infectious SIRS in patients after cardiac surgery with various threshold values for the presence of the infection [7–11], while others prefer monitoring of the kinetics rather than a single PCT value [12]. Knowledge of ''normal'' PCT levels in certain circumstances is essential for biomarker-based diagnostics, but in patients undergoing LVAD implantation data about PCT dynamics after surgery are lacking.

Objective

To assess procalcitonin dynamics after long-term left ventricular assist device implantation and its relationship to infectious complications in the early postoperative period.

Methods

In this single-centre prospective observational study performed between June 2013 and September 2014 a total of 25 consecutive patients indicated for long-term LVAD implantation (implantable HeartMate II VAD) as a bridge to heart transplant were included (INTERMACS profiles: 2–9/25, 3–10/25, 4–6/25). Exclusion criteria were active infection in 48 hours prior to the surgery, immune disorder, immunosuppressive drugs in medication and previous short-term LVAD or extracorporeal membrane oxygenation. General patients' preoperative characteristics are summarised in Table 1.

Procalcitonin levels were assessed before surgery and during postoperative period — 1st, 2nd, 14th and 30th day. Procalcitonin (reference range <0,5 µg/l) was measured on a Roche Cobas 6000 analyser (Roche Diagnostics, Rotkreuz, Switzerland) with the Elecsys Brahms Procalcitonin kit (Roche Diagnostics, Mannheim, Germany). Values were compared according to the presence of infectious complications (IC). Definition of the infectious complication was clinically relevant infection (i.e. positive cultures without any other signs or symptoms of the infection were excluded) confirmed by at least two physicians with reference to the complete medical chart (signs, symptoms, body temperature, blood samples, cultures, imaging methods etc.).

Values are presented as median with interquartile range in µg/l. Statistical analysis using Mann-Whitney test was performed by MedCalc software (version 12.5.0.0) and a p value of 0.05 or less was considered statistically significant. The study protocol has been approved by the local ethics committee and all subjects gave informed consent.

Results

Two patients (8%) died during first 30 postoperative days (POD) — one fatal sepsis (ninth POD) and one multiorgan dysfunction syndrome due to sepsis with right ventricle failure (second POD). In all patients PCT levels were low before surgery — basically in a physiological range (0.16, 0.10–0.35). They raised significantly within first (5.72, 2.18–9.75; p<0.001) and second (5.94, 2.54–11.99; p<0,001) day after operation. Till the 14th and 30th day we observed decrease of PCT back to the baseline values (0.27, 0.11–0.74 and 0.10, 0.06–0.19 respectively), see Figure 1.

Infectious complications occurred after LVAD implant in 7 of 25 patients (28%) and were diagnosed between 1st and 14th POD. There were three cases of sepsis with one fatal sepsis (one non-fatal caused by *S. haemolyticus*, two with unknown microbial agent), two pneumonias (caused by *K. pneumoniae*

Table 1 General patients' preoperative characteristics

demography and comorbitities		therapy		laboratory results		echocardiography and haemodynamics	
age (years)	59 (50-64)	IV diuretics	25/25 (100%)	BUN (mmol/l)	11,3 (7,4-15,6)	LV EDD (mm)	67 (64-79)
ICM/NICM	15/10	inotropes	21/25 (84%)	creatinine (µmol/l)	114,7 (96,6-132,3)	LV EF (%)	25 (22-29)
hypertension	12/25 (48%)	sildenafil	6/25 (24%)	AST (µkat/l)	0,56 (0,38-0,86)	RV dysfunction	22/25 (88%)
hyperlipidaemia	15/25 (60%)	vasopressors	3/25 (12%)	ALT (µkat/l)	0,58 (0,50-0,86)	CVP (mmHg)	11 (7-15)
diabetes	10/25 (40%)	MV	0 (0%)	bilirubin (µmol/l)	25,6 (16,7-38,0)	PVR (Wu)	4,8 (3,5-6,2)
CKD	17/25 (68%)	IABP	0 (0%)	albumin (g/l)	39 (35,1-42,8)	CO (l/min)	3,3 (2,7-3,7)
COPD	6/25 (24%)			haemoglobin (g/l)	126 (112-143)	CI (l/min.m^2)	1,7 (1,4-2,0)

ICM/NICM - ischaemic cardiomyopathy / non-ischaemic cardiomyopathy, CKD - chronic kidney disease, COPD - chronic obstructive pulmonary disease, MV - mechanical ventilation, ECMO - extracorporeal membrane oxygenation, IABP - intra-aortic balloon pump, BUN - blood urea nitrogen, AST - aspartate aminotransferase, ALT - alanine aminotransferase, LV - left ventricule, EDD - end-diastolic diameter, EF - ejection fraction, RV - right ventricle, CVP - central venous pressure, PVR - pulmonary vascular resistance, Wu - Wood units, CO - cardiac output, CU - cardiac index

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