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CLINICAL INFORMATION

Pulse contour analysis calibrated by Trans-pulmonar thermodilution (Picco Plus®) for the perioperative management of a caesarean section in a patient with severe cardiomyopathy[☆]

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KEYWORDS

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Abstract

Background: The delivery of cardiac patients is a challenge for the anaesthesiologist, to whom the welfare of both the mother and the foetus is a main issue. In case of caesarean section, advanced monitoring allows to optimize haemodynamic condition and to improve morbidity and mortality.

Objective: To describe the use of pulse contour analysis calibrated by Trans-pulmonar thermodilution (Picco Plus®) for the perioperative management of a caesarean section in a patient with severe cardiomyopathy.

Case report: We describe the case of a 28-year-old woman with a congenital heart disease who was submitted to a caesarean section under general anaesthesia for maternal pathology and foetal breech presentation. Intra- and post-operative management was optimized by advanced haemodynamic monitoring obtained by pulse contour wave analysis and thermodilution calibration (Picco Plus® monitor). The information about preload, myocardial contractility and postcharge was useful in guiding the fluid therapy and the use of vasoactive drugs.

Conclusion: This case report illustrates the importance of advanced haemodynamic monitoring with an acceptably invasive device in obstetric patients with high cardiac risk. The increasing experience in advanced haemodynamic management will probably permit to decrease morbidity and mortality of obstetric patients in the future.

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PALAVRAS-CHAVE

Cesária;
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Análise do contorno do pulso calibrado por termodiluição transpulmonar (Picco Plus®) para o manejo perioperatório de cesariana em paciente com miocardiopatia grave

Resumo

Justificativa: O parto em pacientes cardíacas é um desafio para o anestesiológico, para o qual o bem-estar tanto da mãe quanto do feto é a questão principal. Em caso de cesariana, o monitoramento avançado permite melhorar a condição hemodinâmica e diminuir a morbidade e mortalidade.

Objetivo: Descrever o uso da análise do contorno do pulso calibrado por termodiluição transpulmonar (Picco Plus®) para o manejo perioperatório de cesariana em paciente com miocardiopatia grave.

Relato de caso: Descrevemos o caso de uma paciente de 28 anos de idade com uma doença cardíaca congênita, submetida a uma cesariana sob anestesia geral devido a afecção materna e apresentação fetal pélvica. O manejo nos períodos intraoperatório e pós-operatório foi otimizado por monitoração hemodinâmica avançada obtida pela análise do contorno da onda de pulso e calibração por termodiluição (monitor Picco Plus®). As informações sobre pré-carga, pós-carga e contratilidade miocárdica foram úteis para orientar a reposição hídrica e o uso de medicamentos vasoativos.

Conclusão: Este relato de caso ilustra a importância da monitoração hemodinâmica avançada com dispositivo aceitavelmente invasivo em pacientes obstétricas com alto risco cardíaco. O aumento do conhecimento no manejo hemodinâmico avançado provavelmente possibilitará a redução da morbidade e mortalidade de pacientes obstétricas no futuro.

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Introduction

In the last twenty years, the number of patients with congenital heart disease who survived until the procreational age has been increasing significantly.¹ These patients, when pregnant, present a high risk of cardiovascular complications, and delivery by caesarean section (CS) is recommended for the more severe cases.² Moreover, preventive anticoagulation is common in patients carrying mechanical valves, which increases the risk of postpartum haemorrhage and variations of intravascular volume during delivery.³

The use of minimally invasive haemodynamic monitors has proven its usefulness in the anaesthetic management of cardiac patients undergoing CS⁴⁻⁷ and cardiac output (CO) measurement with analysis of arterial pulse wave contour, calibrated or not, has been successfully employed in preeclamptic patients undergoing CS.⁸

We describe the case of a patient with a severe left ventricular dysfunction, who was submitted to CS and who benefitted during the perioperative period from a minimally invasive monitoring, using arterial pulse contour wave analysis calibrated with transpulmonary thermodilution.

Case report

A 28-year-old patient was followed-up for her first pregnancy in our tertiary hospital. She had been operated of an atrial septum defect (*ostium primum* type) in the childhood. In the early post-operative period she had suffered a mitral endocarditis that had required a valve replacement, with favourable outcome. Before pregnancy, the patient had no clinical signs of heart failure, except

dyspnoea type II according to NYHA classification. Her treatment consisted of oral anticoagulation (acenocoumarol – Sintrom®), replaced with low molecular weight heparin between the sixth and twelfth week of gestation. The electrocardiogram showed no significant alterations and the chest radiograph revealed an increased cardiothoracic ratio. The transthoracic echocardiogram revealed severe left ventricular systolic dysfunction (LVEF = 24%) with no diastolic impact and a tricuspid regurgitation with a RA-RV gradient of 40 mmHg without impact on right ventricular function.

At 34 weeks of pregnancy, she presented uterine contractions, so an emergency CS was indicated due to maternal pathology and breech presentation. Oral anticoagulation was reversed by an intravenous dose of prothrombin complex (Octaplex®) 40 mL (1000 IU) administered before entering the operating room. After having inserted internal jugular vein and femoral arterial catheters, a Picco® monitor was connected and calibrated with three consecutive bolus of cold saline. General anaesthesia (GA) was induced with a continuous infusion of remifentanil (Ultiva®) at 0.15 mcg/kg/min, etomidate (Hypnomidato®) 0.3 mg/kg and succinylcholine (Anectine®) 1 mg/kg, in rapid sequence. GA was maintained with Sevoflurane (Sevoflurane®) 1%.

After induction of GA, the patient presented hypotension and sinus rhythm around 70 bpm. As shown in Table 1, the volumetric parameters obtained from transpulmonary thermodilution (GEDI and ITBI) were slightly below the acceptable limit. CO was lower than desirable, especially due to a significant decrease in systolic volume index (SVI), not compensated by tachycardia, which could be explained by the action of remifentanil. Similarly, the cardiac function index (CFI) appeared decreased. Guided by a value of Stroke Volume Variation (SVV) above 12–13%, we decided to

Table 1 Summary of perioperative haemodynamic values of Picco®.

	Pre-anaesthetics values	Post-induction values	Post-delivery values	6 h post-operative values
BR (bpm)	70	74	77	68
BP (S/D-M) (mmHg)	102/48–66	96/42–57	112/53–73	105/55–72
CVP (mmHg)	14	12	15	14
CI (L/min/m ²)	2.8	2.7	4.0	3.4
SVV (%)	18	23	19	16
SVI (mL/kg)	40	36	52	50
GEDI (mL/kg)	900	907	1143	733
ITBI (mL/kg)	1080	1134	1273	916
ELWI (mL/kg)	9	8	9	9
CFI (1/min)	3.1	2.9	3.5	4.6
dPmax	900	940	3270	1460
SVRI (dyn s cm ⁻⁵ m ²)	1329	1272	1566	1438

initiate a rapid infusion of 250 mL of hydroxyethylalmidon (Voluven®), confident that the patient's ventricular function was maintained, and that the fluid load would not increase the extravascular lung water index (ELWI). Indeed, the result was a significant increase in SVI (well over 10–15%), which normalized arterial pressure. The ELWI and the CFI values, obtained with a new thermodilution, confirmed the good response to the loading volume and the acceptable efficiency of the ventricle function.

The patient was delivered in 7 min, with no significant blood loss (200 mL), and no significant haemodynamic change. Prophylaxis of uterine atony was provided with a slow infusion of 10 IU of oxytocin (Syntocinon®), administered during 30 min. The total amount of fluid infused along the CS was 750 mL (500 mL of crystalloid and 250 mL of colloid) and the surgery lasted 55 min.

GA was reversed and the patient had her trachea extubated in the operating room. She was then transferred to the intensive care unit with no haemodynamic support. Her good clinical condition was confirmed by arterial blood gas analysis (Table 2).

The anticoagulant therapy with unfractionated heparin at therapeutic dose (target ACT between 60 and 90 s; control value of 32 s) was started 4 h after the end of surgery, once confirmed that the patient did not present excessive blood loss and that the post-operative blood tests were in range.

After 48 h, the patient had maintained a stable haemodynamic state with no need for further fluid loads or vasoactive support (Table 1). The jugular vein and the femoral arterial catheters were removed on the third post-operative day. An echocardiogram was performed on the

fourth day and showed neither worsening of left ventricular systolic function (compared with preoperative values) nor the formation of intracavitary thrombus. Oral anticoagulant was reinitiated the same day, and the patient was transferred to the ward on the fifth day. On post-operative day 10 she was discharged from the hospital, with no post-operative complication.

Discussion

Careful peripartum management of patients presenting cardiac impairment can reduce both morbidity and mortality. A low myocardial contractile reserve, aggravated by physiological changes of pregnancy, can precipitate acute heart failure during delivery. In the most severe cases, in which expulsive efforts might compromise the patient's haemodynamic state, CS is recommended.⁹ When vaginal delivery is possible, a proper management of pain during labour avoids excessive stimulation of the sympathetic autonomic nervous system, and epidural analgesia is a recommendable option to provide efficient labour analgesia.³ Similarly, in case of CS, neuraxial anaesthesia is a very valuable option: it permits to avoid a tracheal intubation, with the risks of unpredictable difficult airway and sympathetic hyperreflexia during laryngoscopy.¹⁰ In our case, CS was performed under emergency conditions in an anticoagulated patient without predictors of difficult intubation: these were the reasons for choosing GA.

The hypervolemia associated with pregnancy reaches its maximum in the last weeks of gestation, with a nadir at the time of delivery.¹¹ In non-pregnant patients with left ventricular dysfunction, little variations of pre- and afterload of the left ventricle are often poorly tolerated, so the risk of heart failure is major at the end of pregnancy and during delivery.

Haemodynamic stability is essential to preserve the maternal–foetal oxygen transport. Therefore, conditions such as hypotension need careful treatment to avoid fluid overload (which can precipitate cardiogenic pulmonary oedema) and unnecessary administration of inotropes or vasoconstrictors, which can be harmful for the foetal–placental circulation. When facing to hypotension during CS, it is essential to differentiate hypovolemia from

Table 2 Post-operative data of arterial blood gas.

	Value	Reference value
pH	7.30	7.35–7.45
pCO ₂	32.5	35–45 mmHg
pO ₂	113	83–108 mmHg
HCO ₃	16	22–26 Meq/L
EB	–9	±3
Lactate	0.9	0.5–2.2 mmol/L

vasodilation and even pump failure. Low arterial pressure coupled to normal or increased CO should be treated by careful infusion of vasoconstrictors, being the same treatment dangerous in hypovolemic patients, thus it strongly decreases placental perfusion, which lacks of autoregulation. On the other hand, even a hypovolemic patient could badly respond to a fluid challenge, if the left ventricle is operating on the flat part of the Frank–Starling curve. In our case, this last scenario could be reasonably suspected, thus a complete haemodynamic monitoring, including volumetric parameters, was certainly indicated.

Protocols based on goal directed therapy (GDT) showed efficiency to improve critical patient prognosis.¹² In our case we used a typical strategy of GDT, assuring primarily that intravascular volume was optimized. The left ventricle's ability to handle with an increase in preload was indicated by the SVV, a dynamic parameter with good sensibility and specificity in detecting fluid responders.¹³ SVV can be used in rhythmic, paralyzed and mechanically ventilated patients, which was our scenario. Moreover, we could employ ELWI to eventually detect cardiac impairment. Estimation of lung water is obtained by transpulmonary thermodilution and, when stable, assure that administered fluids are not increasing cardiac congestion, provoking consequently pulmonary oedema. Identifying a patient who responds to fluid administration permits to avoid the administration of vasoactive drugs (such as dobutamine or noradrenaline), which have been described to alter placental perfusion when not indicated.¹⁴

Advanced haemodynamic monitoring is a must-have in obstetric anaesthesia when facing patients presenting with pathologies like preeclampsia or myocardopathy, among others. Pulmonary arterial catheterization represented the gold standard until few years ago but its use has been reconsidered due to high rates of complications; moreover, pulmonary arterial wedge pressure has been shown to poorly predict fluid responsiveness.¹⁵ Recently, less invasive monitoring technologies have been developed. Arterial pulse wave analysis allows reliable values of CO. Power analysis of arterial wave, calibrated with lithium dilution, has been successfully employed in preeclamptic patients⁸ and this technique only requires peripheral cannulae (venous and arterial). Thus, only transpulmonary thermodilution provides an estimation of ELWI and we considered that this parameter was essential in a patient with left ventricle dysfunction. Non-invasive technologies (volume clamp method, transthoracic bioimpedance, suprasternal Doppler) represent a future hope to guide haemodynamic treatment in risky patients.^{16,17}

In conclusion, the present case illustrates the importance of advanced haemodynamic monitoring coupled to an acceptable level of invasivity in an obstetric patient with high cardiac risk. The increasing experience in advanced haemodynamic management will probably permit to further decrease morbidity and mortality of obstetric patients in the future.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Diller GP, Gatzoulis MA. Pulmonary vascular disease in adults with congenital heart disease. *Circulation*. 2007;115:1039–50.
2. Lupton M, Oteng-Ntim E, Ayida G, et al. Cardiac disease in pregnancy. *Curr Opin Obstet Gynecol*. 2002;14:137–43.
3. Ford AA, Wylie BJ, Waksmonski CA, et al. Maternal congenital cardiac disease: outcomes of pregnancy in a single tertiary care center. *Obstet Gynecol*. 2008;112:828–33.
4. Dyer RA, James MF. Maternal monitoring in obstetric anaesthesia. *Anesthesiology*. 2008;109:765–7.
5. Armstrong S, Fernando R, Columb M. Minimally- and non-invasive assessment of maternal cardiac output: go with the flow! *Int J Obstet Anesth*. 2011;4:330–40.
6. Raghunathan K, Zuegge KL, Connelly NR, et al. Maternal hemodynamic monitoring and the Vigileo monitor. *Anesthesiology*. 2009;111:211–2.
7. Bliacheriene F, Carmona MJ, Madeira Barette C de F, et al. Use of minimally invasive uncalibrated cardiac output monitor in patients undergoing cesarean section under spinal anaesthesia: report of four cases. *Rev Bras Anesthesiol*. 2011;61:610–8.
8. Delachaux A, Waeber B, Liaudet L, et al. Profound impact of uncomplicated pregnancy on diastolic, but not systolic pulse contour of aortic pressure. *J Hypertens*. 2006;24:1641–8.
9. Kawamata K, Neki R, Yamanaka K, et al. Risks and pregnancy outcome in women with prosthetic mechanical heart valve replacement. *Circ J*. 2007;71:211–3.
10. Sellgren J, Ejnell H, Elam M, et al. Sympathetic muscle nerve activity, peripheral blood flows, and baroreceptor reflexes in humans during propofol anaesthesia and surgery. *Anesthesiology*. 1994;80:534–44.
11. Fujitani S, Baldisseri MR. Hemodynamic assessment in a pregnant and peripartum patient. *Crit Care Med*. 2005;33: S354–61.
12. Rivers EP, Coba V, Whitmill M. Early goal-directed therapy in severe sepsis and septic shock: a contemporary review of the literature. *Curr Opin Anaesthesiol*. 2008;21:128–40.
13. Marik PE, Cavallazzi R, Vasu T, et al. Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients: a systematic review of the literature. *Crit Care Med*. 2009;37:2642–7.
14. Guinn DA, Abel DE, Tomlinson MW. Early goal directed therapy for sepsis during pregnancy. *Obstet Gynecol Clin N Am*. 2007;34:459–79.
15. Schiraldi R, Guasch E, Gilsanz F. Indicaciones y Utilidad de la Monitorización del Gasto Cardíaco en la Paciente Gestante. In: Guasch-Arevalo E, Fernandez-López MC, editors. *Controversias en Análgo-Anestesia Obstétrica*. Ergon: Madrid; 2013. p. 83–196.
16. Alhashemi JA, Cecconi M, Hofer CK. Cardiac output monitoring: an integrative perspective. *Crit Care*. 2011;15:214.
17. Cavallaro F, Sandroni C, Antonelli M. Functional hemodynamic monitoring and dynamic indices of fluid responsiveness. *Minerva Anesthesiol*. 2008;74:123–35.