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CLINICAL RESEARCH

Postoperative assessment of left ventricular function by two-dimensional strain (speckle tracking) after paediatric cardiac surgery

Évaluation de la fonction ventriculaire gauche postopératoire par 2D strain *(*speckle tracking*) après chirurgie cardiaque pédiatrique*

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KEYWORDS
Congenital heart disease;
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Left ventricular function;
Echocardiography

Summary
Background. — Left ventricular (LV) dysfunction may complicate paediatric cardiac surgery with cardiopulmonary bypass, notably after long aortic cross-clamping (ACC). Assessment of occult myocardial injury by conventional echocardiographic variables may be difficult in the postoperative period.
Aims. — To evaluate the feasibility of two-dimensional (2D) strain in the postoperative period, and to assess the effect of ACC duration on this variable.
Methods. — Thirty-three paediatric patients (age < 18 years) with congenital heart disease undergoing cardiac surgery with cardiopulmonary bypass were included in this prospective single-centre study. Daily echocardiography was performed from the day before surgery to

Abbreviations: 2D, two-dimensional; ACC, aortic cross-clamping; ANOVA, analysis of variance; CI, confidence interval; CICU, cardiac intensive care unit; CPB, cardiopulmonary bypass; LV, left ventricular; LVEF, left ventricular ejection fraction; POD, postoperative day.

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the fifth postoperative day. LV ejection fraction and LV 2D strain were measured. The cohort was divided into three groups according to ACC duration (group 1: < 30 minutes; group 2: 30—80 minutes; group 3: > 80 minutes).

Results. — Mean age and weight were 4.2 ± 2.5 years and 15.1 ± 5.2 kg, respectively. Feasibilities of longitudinal, circumferential and radial strains were good, and quite similar to conventional variables. Compared with conventional variables, intra- and interobserver agreements regarding 2D strain were better ($r = 0.916$, $P < 0.001$ and $r = 0.855$, $P < 0.001$ for longitudinal strain versus $r = 0.156$, $P = 0.54$ and $r = 0.064$, $P = 0.80$ for LV ejection fraction by Simpson's method). Postoperative evolution of longitudinal and circumferential strains was significantly different between the three groups ($P < 0.001$), whereas there was no difference using conventional variables.

Conclusion. — Postoperative LV 2D strain is a feasible and reproducible method. Strain measurements seem to indicate correlation with ACC duration.

MOTS CLÉS
Cardiopathie congenitale ;
Circulation extracorporelle ;
Function ventriculaire gauche ;
Échocardiographie

Résumé

Contexte. — La chirurgie cardiaque pédiatrique avec circulation extracorporelle peut être compliquée de dysfonction ventriculaire gauche, notamment après une longue durée de clampage aortique. L'évaluation de l'atteinte cardiaque par les paramètres échographiques conventionnels peut être difficile en période postopératoire.

Objectifs. — L'objectif de l'étude était d'évaluer la faisabilité du 2D *strain* en période postopératoire et d'évaluer l'impact de la durée de clampage aortique sur ce paramètre.

Méthodes. — Trente-trois patients âgés de moins de 18 ans, présentant une cardiopathie congénitale nécessitant une chirurgie cardiaque avec circulation extracorporelle, ont été inclus dans cette étude prospective monocentrique. Une échographique quotidienne a été réalisée la veille de la chirurgie au 5e jour postopératoire. La fraction d'éjection ventriculaire gauche et le 2D *strain* du ventricule gauche ont été mesurés. La cohorte a été divisée en trois groupes en fonction de la durée de clampage aortique (< 30 min pour le groupe 1, 30—80 min pour le groupe 2, > 80 min pour le groupe 3).

Résultats. — L'âge moyen et le poids moyen étaient respectivement de 4,2 ± 2,5 ans et 15,1 ± 5,2 kg. Le 2D *strain* longitudinal, circonférentiel et radial avait une bonne faisabilité, similaire à celle des paramètres conventionnels. La variabilité intra- et inter-observateur était meilleure que celle des paramètres conventionnels ($r = 0{,}916$, $p < 0{,}001$ et $r = 0{,}855$, $p < 0{,}001$ pour le *strain* longitudinal versus $r = 0{,}156$, $p = 0{,}54$ et $r = 0{,}064$, $p = 0{,}80$ pour le Simpson). L'évolution postopératoire du *strain* longitudinal et circonférentiel était significativement différente entre les trois groupes ($p < 0{,}001$).

Conclusion. — Le 2D *strain* est une méthode faisable et reproductible en postopératoire. L'évolution postopératoire de ce paramètre semble être corrélée à la durée de clampage aortique.

Background

Cardiopulmonary bypass (CPB) is routinely used in the surgical repair of many congenital heart diseases. CPB is one of the causes of postoperative left ventricular (LV) dysfunction [1—3], which can result in low cardiac output syndrome and multiple organ failure. Therefore, reliable assessment of postoperative LV function is necessary. Echocardiography is the gold standard in the cardiac intensive care unit (CICU), using visual assessment and measurement of LV ejection fraction (LVEF) using the methods of Teichholz or Simpson. However, these methods lack reliability and reproducibility, especially when the cardiac anatomy is abnormal [4,5].

Analysis of two-dimensional (2D) strain by speckle tracking is a 2D echocardiographic technique that relies on a frame-by-frame follow-up of acoustic markers, called ''speckles'', through the myocardium [6,7]. Speckle displacement represents myocardial motion, and ventricular function can be studied in several dimensions (longitudinal, radial and circumferential). The value of this technique has been demonstrated in several cardiovascular diseases in adults and children, for diagnosis, prognosis and treatment [8—10]; however, its use in the CICU after paediatric cardiac surgery has not been studied so far.

The main objective of this study was to evaluate the feasibility and reproducibility of LV 2D strain after congenital

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