Disruption of the ventricular myocardial force-frequency relationship after cardiac surgery in children: noninvasive assessment by means of tissue Doppler imaging.

OBJECTIVE: Impaired ventricular function after cardiopulmonary bypass and surgical repair remains a commonly encountered clinical problem. We hypothesized that the well-described impairment of calcium cycling after cardiac surgery would significantly affect the ventricular myocardial force-frequency relationship, which can be measured noninvasively by using the tissue Doppler echocardiography-derived index of contractility isovolumic acceleration. METHODS: Children undergoing repair of congenital heart defects were studied. Rate-related changes in contractility were measured by means of simultaneous atrial pacing and tissue Doppler echocardiography preoperatively and postoperatively. RESULTS: Although closure of atrial septal defect did not affect ventricular myocardial systolic performance, closure of ventricular septal defect lead to a marked postoperative decrease of basal contractile force (2.0 +/- 0.7 m/s² preoperatively vs 1.0 +/- 0.7 m/s² postoperatively, P<.02). Furthermore, the force-frequency relationship curves were significantly different (P<.001), with a reduced force-rate trajectory, and also peak force was attained. Neonates undergoing the arterial switch procedure showed the most marked postoperative decrease of isovolumic acceleration at basal heart rates and force-frequency relationship with reduced trajectory.
and peak force development (P< .0001). CONCLUSIONS: This is the first clinical study describing the noninvasive acquisition of ventricular force-frequency relationships in children undergoing operations for congenital heart disease. There is a marked variability in response, ranging from no effect in patients undergoing atrial septal defect closure to a profound reduction in myocardial contractile responses after neonatal arterial switch. This simple noninvasive method allows measurement of a hitherto rarely examined property of the myocardium, an understanding of which might allow refinement of myocardial protection and postoperative myocardial support.