Function Analysis of Mitral Complex's Geometry using Support Vector Machines from 3D Echocardiography

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In order to assist diagnosis and surgical repair of congenital mitral disease, quantitative analysis of 3D geometry of the mitral complex during the cardiac cycle is necessary for better understanding mechanism and dysfunction of the mitral complex. From an anatomic point of view, mitral complex consists of mitral annulus, mitral leaflets, chorea tendineae and papillary muscles, and their geometric features characterize the behavior of mitral valves. This work aims to extract geometric parameters of mitral complex and utilize Support Vector Machines (SVM) based classifier to support diagnosis of congenital mitral regurgitation (MR). Our work includes the following steps: (1) select hinge points of mitral complex and reconstruct its 3D geometric configura-tion; (2) establish its local coordinate reference plane independent of global heart motion as well as orientation and location of scanning probe; (3) calcu-late geometric parameters depicting geometry of mitral apparatus: effective annular area, papillary annular distance, inter-papillary distance, and papil-lary muscle angle; (4) normalize these parameters by body surface area (BSA) as a compensation for difference of age, gender and body habitus. With a control group of 20 normal young children (11 boys, 9 girls, mean age 5.96 ± 3.12 years) with normal structure of mitral apparatus, 20 patients (9 boys, 11 girls, mean age 5.59 ± 3.30 years) suffering from severe congenital MR are recruited in this study. The results of parameter validation demonstrates that the measurement precision is in the range of inter-/intra-observer variability. SVM-based classifier achieves average classification accuracy at 85.0% in the present population, holding the potential to conduct preoperative planning and to explore quantitative association between the geometry of the mitral complex and the mechanism of the congenital MR.