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Quantitative Evaluation of Mitral Regurgitation by Using Color Doppler Ultrasound

Authors : Shang-Yu Chiang, Yu-Shan Tsai, Shih-Hsien Sung, Chung-Ming Lo

Abstract : Mitral regurgitation (MR) is a heart disorder which the mitral valve does not close properly when the heart pumps out blood. MR is the most common form of valvular heart disease in the adult population. The diagnostic echocardiographic finding of MR is straightforward due to the well-known clinical evidence. In the determination of MR severity, quantification of sonographic findings would be useful for clinical decision making. Clinically, the vena contracta is a standard for MR evaluation. Vena contracta is the point in a blood stream where the diameter of the stream is the least, and the velocity is the maximum. The quantification of vena contracta, i.e. the vena contracta width (VCW) at mitral valve, can be a numeric measurement for severity assessment. However, manually delineating the VCW may not accurate enough. The result highly depends on the operator experience. Therefore, this study proposed an automatic method to quantify VCW to evaluate MR severity. Based on color Doppler ultrasound, VCW can be observed from the blood flows to the probe as the appearance of red or yellow area. The corresponding brightness represents the value of the flow rate. In the experiment, colors were firstly transformed into HSV (hue, saturation and value) to be closely align with the way human vision perceives red and yellow. Using ellipse to fit the high flow rate area in left atrium, the angle between the mitral valve and the ultrasound probe was calculated to get the vertical shortest diameter as the VCW. Taking the manual measurement as the standard, the method achieved only 0.02 (0.38 vs. 0.36) to 0.03 (0.42 vs. 0.45) cm differences. The result showed that the proposed automatic VCW extraction can be efficient and accurate for clinical use. The process also has the potential to reduce intra- or inter-observer variability at measuring subtle distances.

Keywords : mitral regurgitation, vena contracta, color doppler, image processing
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