Quantitative Assessment of the Effects of Annuloplasty on Mitral Annulus Dynamic Geometry using Real-Time 3D Echocardiography

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Mitral valve (MV) repair is the preferred treatment for mitral regurgitation associated with organic MV prolapse (MVP) . Our goal was to describe the dynamic changes in mitral annulus (MA) geometry following MV repair with annuloplasty, using custom software for MA tracking from transthoracic real-time 3D echocardiography (RT3DE). Methods. Forty-four patients (62 ± 11yrs) with organic MVP and ejection fraction (EF)$>55\%$ were studied by RT3DE the day before MV repair (23 received a complete rigid ring - RIG, 21 an incomplete flexible one - FLEX), and 3 and 6 months after. An age-matched group of 20 normal (NL) subjects (57 ± 9yrs) was studied as control. After manual initialization, the MA was tracked frame-by-frame in the 3D space, and several parameters were computed: min and max 3D surface area (A), delta area (DA=maxA-minA), 2D projected vs 3D surface area ratio (A2D/A3D), max longitudinal displacement (LD), mean height (H) and delta height (DH=maxH-minH). Differences vs pre-surgery, and in MVP vs NL values were tested ($p<.05$). Results. As expected, MVP had an enlarged MA resulting in greater area and height during the cardiac cycle, leading to a reduced planarity compared to NL. Annuloplasty resulted in: 1) reduced area in both RIG and FLEX, with minimal DA during the cardiac cycle; 2) more planar MA shape, as depicted by a reduced H and an increased A2D/A3D. Interestingly, at 3- and 6-months, FLEX height was greater than RIG, due to the lower planarity associated with incomplete ring design compared to the complete one. At 6-months, all values were found unchanged. Conclusions. MA dynamic analysis from RT3DE was feasible in patients undergoing MV repair, giving new insights in the in-vivo performance of the implanted annular prosthesis. This would constitute a new useful tool for the surgeon in the clinical decision process and in follow-up monitoring.