THE FLOW PATTERN OF MITRAL VALVE CLOSURE

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A mathematical method for studying the physiology of mammalian heart valves has been developed. Solutions to the equations of motion of the blood-valve-heart system are constructed with a digital computer. The method incorporates the flexibility of the valve leaflet and the active muscular properties of the heart wall. Cine films of the motions of the simulated valve and fluid are produced and compared with cine films of the cusp motions of the canine mitral valve. We use this technique to study the physiology of mitral valve closure.

Four distinct streamline types are identified, together with a universal sequence of their appearance in time during a single diastole and a hierarchy of their effects on valve performance. Of these, only type B, the circulating streamline, closes the valve without reducing the ventricular volume. In our work the circulating streamlines are only formed when the open valve is restrained by the chordae. This contrasts with the views of some workers that the chordae are slack during diastole, and it shows the power of this technique in raising important questions about valve physiology.

These mathematical methods can be applied to the design of prosthetic valves, and to the analysis of their performance.