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Studies on Porcine Bioprosthetic Heart Valves at Henry Ford Hospital: An Overview

The following papers on porcine bioprosthetic heart valves represent the combined experience of a diverse group of investigators at Henry Ford Hospital over the last ten years. Unified by their common subject and purpose, these articles provide an overview of the state of the art on various aspects of porcine valve degeneration.

The problem of the failure of porcine bioprosthetic valves has worldwide interest; over 150,000 such valves have been placed in patients throughout the world. At Henry Ford Hospital, we are actively following patients who have had a total of 744 porcine bioprosthetic valves implanted. These valves were first implanted in 1971 by Dr. Julio C. Davila. In recent years, work has been continued by Dr. Donald J. Magilligan Jr, and his associates, Drs. Fernando M. Jara, Joseph W. Lewis, Jr, and J. Lance- lot III. Many of these patients are available for follow-up studies. Because our medical center has such a large population of patients, we have had an opportunity for an in-depth investigation of porcine valve degeneration that is available at few other institutions. It is time, we believe, to share our ten years’ experience with the community. Any insight related to the early detection of valve degeneration, mechanisms of degeneration, and potential therapeutic interventions is important.

For the most part, these papers are review articles that summarize our present state of knowledge on various aspects of porcine valve degeneration, although in some instances preliminary findings are being published for the first time. This compilation of our collective experience is unique, in our judgment; no other institution has as many lines of inquiry being brought to focus on this single field as are represented here. The results of this concentrated effort provide an exponential rather than a merely additive gain of knowledge. We are fortunate to have the Henry Ford Hospital Medical Journal as a suitable forum for disseminating this information and making these papers available to readers as a unified group.

The organization of this compilation is as follows. An introductory article on the “Natural History of the Porcine Bioprosthetic Heart Valve” by Magilligan describes how the prevalence of degeneration of bioprosthetic valves relates to age, sex, valve position, anticoagulant therapy, and the method of fabrication, as estimated by the year that the valves were implanted. The remaining papers fall into two main groups: three papers describing diagnostic methods for the early detection of bioprosthetic valve degeneration and four papers presenting information on possible causes of porcine bioprosthetic valve degeneration.

New methods for the early detection of bioprosthetic valve degeneration will become particularly important if specific therapeutic interventions become possible. At the moment, the diagnosis of valve degeneration depends primarily on detecting a murmur indicative of regurgitation (or, less commonly, stenosis), which is subsequently evaluated at cardiac catheterization. The possibility that degeneration may be detected before the diagnosis is apparent by auscultation is being explored by several methods. As discussed in the article by Stein, Sabbah, Lakier, and Magilligan, the analysis of the frequency content of heart sounds and of murmurs is one method that appears promising. From these studies, we have also increased our understanding of some aspects of cardiac auscultation, including the mechanism of musical murmurs and factors that affect the frequency of heart sounds.

M-mode and two-dimensional echocardiography is another method for detecting early degenerative changes that has received considerable attention at our institution. This is described in the article by Alam, Lakier, Pickard, and Goldstein. Echocardiographic diagnostic criteria for bioprosthetic valve stenosis and regurgitation have been developed at Henry Ford Hospital on the basis of studies of this group of patients.

A diagnostic approach uniquely suited to the quantitative assessment of bioprosthetic valves is orifice-view roentgenography, which is discussed by Stein, Brymer, Anbe, Sabbah, and Folger. In this method, the valve orifice can be visualized en face as contrast material is injected into the aorta or the left ventricle.

The final four papers offer information and speculations on possible causes of the degeneration of porcine valves. Fluid dynamic stresses in the region of the valve, which are discussed by Sabbah and Stein, may relate to valvular degeneration directly through fluid forces that act upon the valve or indirectly through effects of such fluid stresses upon formed elements in the blood. In the article by Riddle, Stein, and Magilligan, the possibility of...
an interaction of platelets and white cells with porcine bioprosthetic valves is suggested by the electron microscopic demonstration of cells and platelets on the surface of degenerated bioprosthetic valves. Also, platelets were activated in the circulating blood of patients with degenerated bioprosthetic valves. Cellular deposits on the valve surface are compatible with the possibility of an immune reaction, as is the higher rate of valvular degeneration in younger patients. The possible role of immune mechanisms in bioprosthetic valve degeneration is discussed in the article by Heinzerling, Stein, Riddle, Magilligan, and Jennings. The last paper of this group, by Helpern, McGee, and Riddle, presents some speculations about the mechanism of valve calcification and its relation to proteins containing gamma-carboxy-glutamic acid.

In spite of a significant incidence of degeneration several years after implantation, porcine valves remain the preferred type of prosthetic heart valve at this and many other institutions. Insight into the mechanism of degeneration, combined with an ability to diagnose subclinical degeneration through the various approaches we describe, perhaps may lead to interventions that prevent or delay the degenerative process.

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