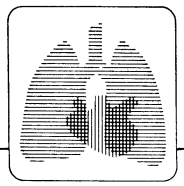

medical history

Giovanni Paladino: True Father of the Accessory Myocardial Conduction Pathways

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The existence of atrioventricular (A-V) conduction pathways is taken for granted today, but it took much effort on the part of anatomists and physiologists at the turn of the century to prove this concept. The writings of Kent[1] and His[2] on this topic are the most widely known. They published their results independent of one another in 1893, each describing a muscular connection between auricles and ventricles of the human heart. Since then, in the medical world, the primary myocardial conduction pathways have been known as His bundles while the accessory pathways are Kent bundles. More recently, other A-V conduction bundles have been described in locations other than lateral (Kent) or medial (His); some of these pathways are thought to be responsible for bundlectomy failures in the surgical treatment of Wolff-Parkinson-White syndrome.

For the past century, however, we appear to have neglected the first description of A-V muscular connections. Giovanni Paladino,[3] an Italian physiologist, in the *Movimento Medico Chirurgico di Napoli* of November 1876, described muscle bridges going from the atrium, through the valve cusps and chordae tendineae to the papillary muscles and ventricular walls. His studies were performed on human, horse, donkey, ox, buffalo, cat, chicken and turtle hearts and described "fibers which are resistant yet extensible, elastic and contractile which must undoubtedly be important in the mechanics of the cardiac pump."

Paladino's work is mostly descriptive, both in gross and microscopic terms. In his words,

> the muscle layer of the atria, arriving at the level of the atrioventricular ostia, loses the more external layers of circular fibers which stop here, and combines with the longitudinal and intermediate circular fibers down to the internal aspect of the valve cusps. Of these fibers, the longitudinal ones end in the tendons of second and third order and some fascicles go directly to the ventricle wall where they become tendons in the midst of flattened muscle fibers which insert on the valve leaflets.

(The tendons of second and third order were defined as "terminations of the atria" and "insertion cords for the atrial myocardium onto the ventricle walls").

Paladino describes histologically "variable numbers of fibers separated by significant areas of connective tissue, which are clearly different from the muscle perimisium." These fibers are described as being smaller than other cardiac fibers, with thin striae and granulations. Paladino thus concluded that the A-V valves are provided with muscle fibers deriving from both atria and ventricles, but while the ventricular components are only small buddings, those derived from the atria "must be considered an actual extension of the atrial mesocardium." He firmly stated that at least in the mammalian heart, the atrial musculature does not end at the level of the fibro-cartilaginous rings of the A-V ostia, but in part continues downward to insert on the ventricular walls and on the papillary muscles via a portion of the "valve tendons." He thus claimed that "the disposition (of the fibers) disproves the two universally repeated, cardinal anatomic features of heart structure: 1) that the musculature of the atria and of the ventricles are separate and differentiated at the level of the atrioventricular openings, and 2) that the fibrocartilaginous rings are the ending and starting points of the mesocardial muscle fibers."

In an attempt to provide a physiologic explanation for his anatomic findings, Paladino performed a series of experiments on isolated animal hearts. He observed that in one area of the right atrium the contractions persisted much longer than elsewhere and the contractions of selected bundles of fibers extended from the atria through the valves to the ventricle wall and the ventricular bundles he called "transverse." These contractions were observed to occur both spontaneously and with electrical stimulation, as were contractions of

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the "muscle fibers extending from the ventricle wall to the valve cusps." Paladino thus concluded that the A-V valves are contractile and that their motion is a propagation first of atrial and then ventricular contraction. Most of his work was indeed directed toward providing an explanation for heart valve motion synchronous with atrial and ventricular contraction. He believed that the valve musculature "not only allows movement of the valves themselves, but also provides solidity to the union between atria and ventricles, and contributes in a special way to the general and total mechanism of the cardiac pump."

Paladino does indeed appear to have provided the first description of muscular pathways responsible for the coordinated contraction of atria and ventricles, albeit in a different location from those later described by Kent and His. The Paladino bundles, and not those of Kent, are therefore the "original" accessory myocardial conduction pathways. In view of present-day knowledge of heart physiology, Paladino's interpretation of heart valve function (the main goal of his work) was rather simplistic and essentially incorrect. Despite these fallacies, he made some very important structural observations which he successfully correlated with overall myocardial physiology. (In later experiments, described in 1914, Paladino may actually have performed the first bundlectomy when showing that despite division of the His fibers, normal function would persist, presumably via an intact Paladino system).

Giovanni Paladino therefore deserves the credit for recognizing the now accepted contractile and conductive capacities of this "special muscle system in the heart."

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