EDITORIAL

Intertwining Myocardial Bands: an Anatomy-based Proposal for "Axial" and "Radial" Activation of the Heart

El entrecruzamiento de las bandeletas: una propuesta anatómica para la activación "axial" y "radial" del corazón

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From the point of view of biophysics, the high efficiency of the heart as a pump can only be explained by a complex anatomy. However, the anatomic description of Torrent Guasp (1) as a structure formed by a muscular band that begins at the level of the pulmonary valve and ends at the level of the aortic root, forming a double helical loop which limits the ventricles, has been interpreted by many investigators as a ''physiological convenience'', (2) given the difficulty for identifying the band by direct or instrumental dissection. Diffusion tensor magnetic resonance imaging confirms this anatomical model by providing information of myocardial tissue and of the architectural organization of the fibers. (3)

The article by Trainini et al. published in the Argentine Journal of Cardiology (4) can be considered in the group of studies performed by some investigators in an attempt to provide "functional evidences" of the anatomical existence of the ventricular myocardial band. In an experimental model in open-chest pigs using sonomicrometry, Cosín Aguilar (2) was able to confirm the sequence, as established by Torrent-Guasp, with which the contractile wave would progress along the band. However, the most important doubts and even contradictions about Torrent-Guasp's model of heart function come from ventricular activation maps. (5) In a publication in 1988, the author expressed that: (6) "The aim of the present article is to explain the mechanism by which the contractile activity of the heart reduces (due to blood ejection) and enlarges (due to blood suction) both ventricles, and requires a new interpretation of the way in which the activation is conducted throughout the ventricles. Therefore, in order to validate what has been exposed about such new understanding of cardiac mechanics, it would be convenient to carry out an experimental study with the only purpose of demonstrating the reality of this new interpretation about the conduction of activation…" Torrent-Guasp questioned the radial endocardial-to-epicardial electrical activation of the heart established by Lewis in the first half of the 20th century; and based on different experimental studies that he described in his publication he defined an axial propagation of activation along the ventricular myocardial band starting in the subepicardium, except in the left ventricular anterior wall. (6)

In this context, the article by Trainini et al. becomes particularly relevant, as he tries to relate the sequence of electrical activation of the heart measured by electroanatomic mapping using the Carto navigation and mapping system, with the sequence of myocardial contraction, in an attempt to understand three key aspects of cardiac physiology: ventricular torsion, the mechanism of active suction during the diastolic isovolumic phase and the significance of the residual systolic volume. The design of the study in hearts of patients undergoing catheter ablation of an anomalous pathway also provides significant uniqueness compared to previous evidences. The investigators do not supply information about the variability of the results obtained in the five electrophysiological studies, whether it is identical in all of them or if the sequence of electrical activation of the heart, expressed in the results, is the sum of the data obtained from all the patients. Among the results, this study provides the following electrophysiological evidences regarding the activation of the left ventricle:

- Depolarization starts in the interventricular septum.
- The activation propagates through the septum to the apex ("axial" activation) and, at a certain point, simultaneously propagates towards the epicardium ("radial" activation)
- The epicardial activation extends in two opposite

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directions: towards the apex and towards the base of the left ventricle, reaching the subaortic portion at a later phase.

These results show an activation sequence that is different from that described by Torrent-Guasp and Buckberg (7) in 2001 and demonstrate an "axial" and "radial" distribution, similar to the description of Lewis. This activation map could explain the opposing contraction ("torsion") of the base and apex, and the active suction effect for ventricular filling due to the final contraction of the base that would produce ventricular enlargement and untwisting. From this point, and as the own authors recognize in the study limitations, "the discussion could be considered speculative, as the interpretations of the anatomy or hemodynamics were based on an electrophysiological study without performing morphological dissections or measuring pressures, volumes or dimensions". In our personal view, we share the physiological model of the three-phase heart proposed in the study, by placing suction as a different period between systole and diastole, with myocardial contraction and enlargement of the heart but without ejection. In our opinion, as a surgical team active in surgical ventricular restoration for the treatment of heart failure, (8), the oblique and intertwining disposition of the myocardial fibers is an anatomic fact essential for ventricular "torsion". If ventricular volume increases and myocardial fibers acquire a horizontal disposition, torsion becomes less efficient and becomes a simple shortening. The anatomic model proposed by Trainini et al. which slightly modifies Torrent-Guasp's model results attractive, as it introduces the existence of an anatomic point named "crossing of band segments" from which the "radial" endocardial-to-epicardial activation is generated. This point, of extremely physiological importance, could only be assimilated to Torrent Guasp's "aberrant fibers" of the ventricular myocardial band dissection.

Thus, we are facing an almost accepted myocardial physiology, with two critical aspects: ventricular "torsion "and "active suction due to contraction", which correlate with "axial" and "radial" activation of the heart, and with an anatomic model which we believe is based on Torrent-Guasp's "ventricular myocardial band". The technical issues related with the band dissection allow points of discussion and uncertainty, to which the present study by Trainini et al. provides an elegant proposal.

Conflicts of interest

None declared.

(See authors' conflicts of interest forms in the website/Supplementary material).

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