Advances in Cardiac Research

Flow Focus

Renaissance of 21st Century in Cardiovascular Science: From Leonardo Da Vinci to Artificial Intelligence

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"If I have seen further, it is by standing on the shoulders of Giants." Sir Isaac Newton, 1675.

In the ever-evolving field of cardiovascular science, we must learn from the great minds of the past to avoid getting trapped in outdated ideas. Leonardo Da Vinci and William Harvey are two of the most powerful examples of pioneers who challenged prevailing notions and paved the way for transformative advancements. As we stand on the precipice of the artificial intelligence (AI) era, their wisdom becomes even more relevant.

Da Vinci, the epitome of a true Renaissance man, ventured into the intricate workings of the cardiovascular system centuries ahead of his time. His experiments with blood flow across the aortic valve, using water mixed with tiny grass seeds to mimic hydrodynamics, yielded profound insights. Most notably, he astutely observed that the closure of the aortic valve was not solely governed by pressure differences, as widely believed, but rather by the elegant dance of vortex formation. He described the "revolving impetus" that propelled the blood, causing it to beat against the valve cusps and ensure closure. Da Vinci's revolutionary perspective sparked a journey so progressive that was left unnoticed until late twentieth century.[1]

Similarly, Harvey, often hailed as the father of modern cardiovascular physiology, shattered long-standing misconceptions about blood circulation. Amidst considerable resistance, he unraveled the complex dynamics of the cardiovascular system based on hemodynamics and pressure-based physiology. His work laid the foundation for life-saving interventions and sparked a paradigm shift in our comprehension of the circulatory system. Harvey refused to follow the "Galenism" mindlessly. Like Da Vinci, Harvey's unwavering dedication to scientific inquiry inspires us to question prevailing notions and push the boundaries of knowledge.

Nevertheless, we find ourselves at a critical juncture in the 21st century, where AI has emerged as a powerful tool with the potential to revolutionize cardiovascular science. We must break free from the shackles of "Harveyism" and venture into uncharted territory. This task entails moving beyond the confines of traditional hemodynamics and embracing a more comprehensive approach that includes the pressure-volume Loop (PV loop) and the complex phenomenon of vortex formation within the heart.

There is a glaring knowledge gap in cardiovascular science regarding the significance of PV loops and the intricate dynamics of vortex formation (Figure 1).[2-4] Only a handful of case reports and limited clinical data shed light on these crucial aspects of cardiac function. This knowledge gap presents a unique opportunity for us to harness the potential of AI in filling these gaps and painting a clearer picture of the intricate interplay between flow, pressure, perfusion, and the bioenergetics of the heart.

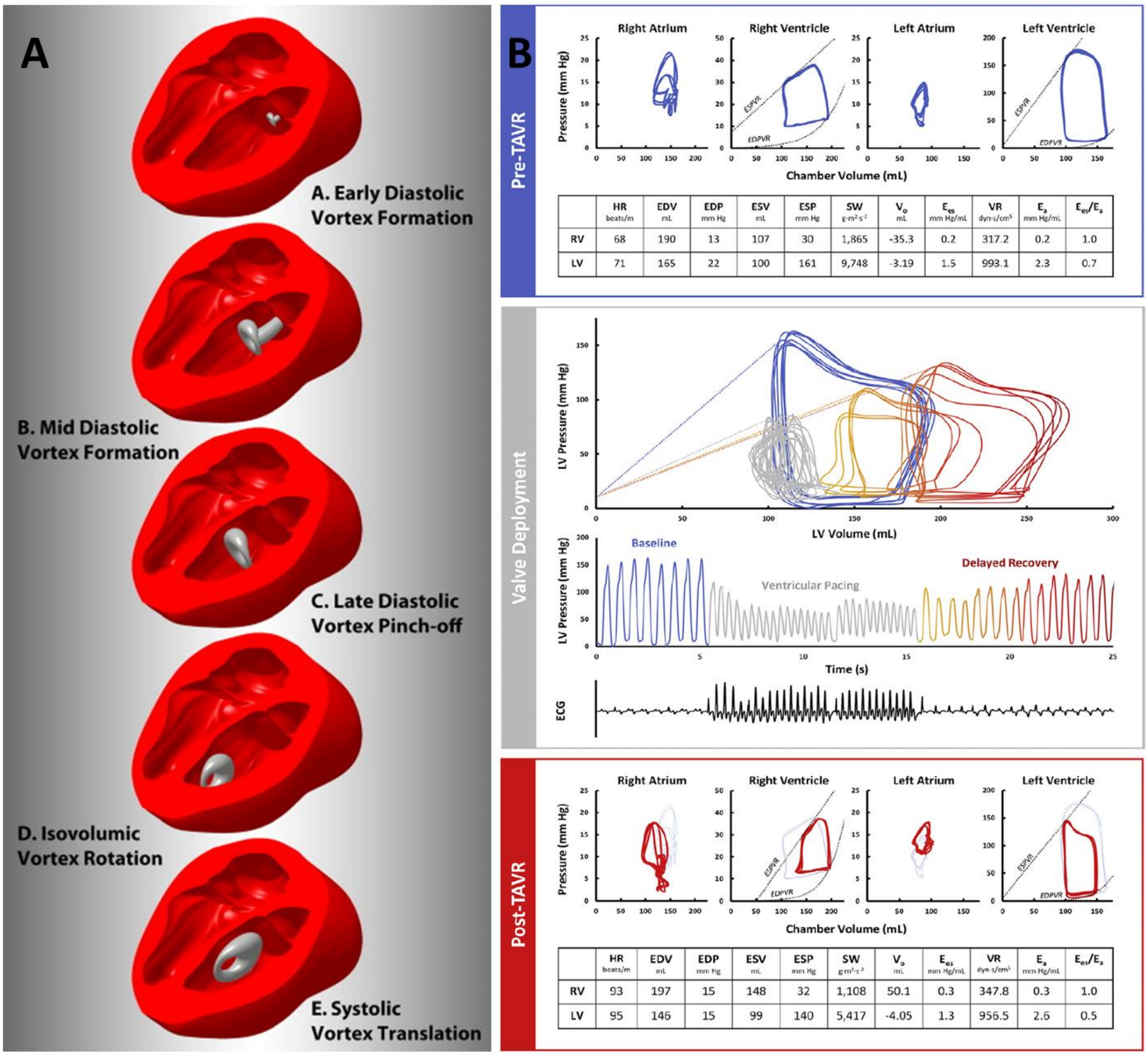

Figure 1. (A) Importance of the delicate pathway of blood flow from the left atrium to the left ventricular outflow tract (LVOT) throughout diastole. Note that a mass of blood moves towards the LVOT during diastole and before the systole begins. Figure 1B demonstrates the value and importance of a pressure-volume loop in a patient with severe bicuspid aortic stenosis undergoing transcatheter aortic valve replacement. Note the reduction of contractility and the changes in left ventricular volume immediately after the rapid ventricular pacing and the diminished stroke volume (the width of the PV loop) after valve replacement. This might be one reason for reduced transaortic gradient immediately after transcatheter aortic valve replacement, which is often increased a few hours to a few days after the procedure by regaining the normal stroke volume.[2-4]

By harnessing the power of AI, we can overcome the limitations of traditional methodologies and embark on a transformative journey toward a deeper understanding of the cardiovascular system. AI algorithms can analyze vast amounts of data, uncover hidden patterns, and provide once unimaginable insights. By incorporating PV loops and vortex formation into our research and clinical practice, we can unravel new dimensions of cardiac function and gain a more holistic understanding of cardiovascular physiology.

In this esteemed journal, we recognize the need for a dedicated space to explore the complex intricacies of circulation beyond hemodynamics and pressure-based physiology. These seemingly sophisticated topics hold immense relevance and practical implications for daily clinical practice. By delving into the nuances of these concepts, we can bridge the gap between scientific research and its translation into meaningful patient care. Our commitment to fostering a deeper understanding of these essential aspects of cardiovascular science will empower healthcare professionals to make informed decisions and provide their patients with the highest level of care. Through exchanging knowledge and ideas within this journal, we aim to cultivate a community of researchers, clinicians, and innovators who share a common vision of advancing cardiovascular medicine through a comprehensive understanding of hemodynamics, flow dynamics, and vortex flow formation.

In conclusion, we stand on the shoulders of giants like Da Vinci and Harvey, who have shown us the importance of challenging prevailing dogmas and embracing new paradigms. With AI as our ally, we have the tools to bridge the knowledge gap and unlock the mysteries of the cardiovascular system. Let us embrace this opportunity, transcend the limitations of hemodynamics, and embark on a journey of discovery that will shape the future of cardiovascular science.

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