

False Narratives Drive Research in Early Cardiac Morphogenesis A Critical Analysis of Methodology and Interpretation

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Abstract

Cardiac looping, the morphogenic event transforming the embryonic tubular heart to a curved C-shape, is essential for normal continued development. A defect in looping may contribute to congenital heart defects. Looping is also an example of morphogenesis that should be amenable to experimental analysis.

The past three decades of research into the mechanism of cardiac looping have been based on a cascade of flawed data that created a false narrative and paradigm. The present analysis of these decades' published studies of heart looping demonstrates that science is not inherently self-correcting. Showing how false narratives influenced subsequent research, this work also documents the ensuing scientific consensus that resulted in a literature of contradictory or incorrect data. It may be impossible to unravel the resulting morass of inaccuracies.

Careful reading of original papers demonstrates that many published studies of heart looping used highly selected data. Most computer models examine only the material properties of the myocardium and ignore the other components of the heart tube although it has been established that these are critical to the generation of normal anatomy. Some studies have attributed fabricated physical properties to functionally important components of the tubular heart.

Although fundamental material properties of the embryonic tubular heart wall had been ascertained experimentally much of this data was not incorporated into later computer models and its omission resulted in erroneous results. The cascade of publications based upon questionable data or incorrect analysis of existing data contributed to the establishment of an alternative narrative.

Several publications that had profound effects on later research are shown to contain misleading data or conclusions inconsistent with the published results. Throughout this period some striking contradictions, or anomalies, in experimental findings were overlooked or misreported and significant earlier findings ignored or discarded to facilitate finite element modeling. The present work also documents a pernicious phenomenon: misuse of papers published earlier, either by overt misstatement of their contents or by selective inclusion in (or exclusion from) bibliographies.

As a historiography, this is not intended to survey the literature nor does it attempt to propose a definitive mechanism for cardiac looping. Rather it explores the nature of evidence, the role of anomalous findings, the assembly of discrete experiments into cohesive models, the introduction of biases, and how the historical record of published papers may be manipulated. Recent developments in the philosophy of development are shown to be relevant to the study of cardiogenesis. These philosophical advances, particularly in modularity and generative entrenchment, suggest fundamental conceptual errors in many contemporary studies. It is argued that no defined morphological endpoint has been articulated and if we cannot articulate the problem, we cannot answer it.

The conclusion that a false narrative has been imposed upon the field of early embryonic cardiogenesis is a disturbing outcome of this study. The false narrative distorts future research into embryogenesis as well as corrupting studies of the early developmental basis of congenital heart disease.